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THE 68TH STREET LAKE TUNNEL, AT CHICAGO, is meeting with trouble in the form of a bed of fine black sand encountered in the clay bed under the lake. This tunnel is a continuation of work commenced in 1892. About that time two tunnels, one 5 ft. and the other 6 ft. in diameter, had been driven out about one mile under the lake by the authorities of Lake and Hyde Park for an improved water supply. The city of Chicago, later, planned a 7 ft. tunnel to extend out two miles and a contract was let and work commenced from a temporary crib two miles out. This tunnel was excavated 4,000 ft. towards the shore and work was then stopped to await the completion of the tunnel driven from the shore. In building from the crib, bad ground was struck 3,980 ft. from the crib, and for some distance a parallel tunnel was driven 150 ft. from the old line. The present tunnel is being driven from another crib, one mile from shore, and at the ends of the old 5 and 6 ft. tunnels and the present face of the tunnel is now about 960 ft. out from the foot of the shaft. At about 800 ft. out the conditions met with have compelled the use of an air-lock and compressed air. Beyond this point the material has changed to sand and the roof has caved in places to a height of 12 ft.; water also drips through. The engineers believe that they have struck the bed of an ancient river; while geologist Ossian Guthrie says that it is a track excavated by a glacier, which also practically cut out the depression now followed by the Drainage Canal.

UNBALANCED BIDS IN JERSEY CITY are ruled out by a recent action of the Street and Water Commissioners. On Aug. 17 the board adopted a resolution providing that the Chief Engineer be and is hereby directed to file with the clerk of this board a schedule of the various items which enter into the construction of public sewers and into the making of public improvements, together with a fair maximum and minimum price on each item.

Bids under this rule were received for the first time on Sept. 14, the work in hand being sewers and asphalt paving. According to the Jersey City "Journal" the results of the change were most gratifying, there being far more competition than usual and prices being remarkably low, in comparison with the past. A few unbalanced bids were thrown out. In addition to the few contractors that have usually bid on city work for several years past were a number of bidders of high standing who have not been in the habit of competing for the city work. The "Journal" attributes a large drop in the price of asphalt pavement to reforms wrought by the new rule, resulting in real competition. There were three bidders for asphalt pavement. The lowest bidder was the Barber Asphalt Paving Co., which bid $1.65 per sq. yd., against its own bid of $2.39 a year ago. The next lowest bid this year was $1.95, submitted by the New Jersey Mexican Asphalt Co., which has recently built a plant near the boundary line between Jersey City and Hoboken, and secured a contract in the latter city.

THE ALLEGHENY RIVER having been improved by the construction of the Davis Island dam, which gives Pittsburg a harbor at all stages of water, and by partial completion of a lock and dam at Herr's Island, Major Powell, of the Engineer Corps, U. S. A., has now ordered further surveys of the river between Oil City and Tarentum. When the surveys are completed, Major Powell will report as to how far the Allegheny River can be made navigable, with estimates as to the dams and locks required for this purpose. With the dams at Herr's Island, Six Mile Island and Springdale finished—and all of these have been authorized—the river will be navigable to Tarentum for 6 ft. draft, or the same as on the Monongahela. The Allegheny River drains 13,000 sq. miles of territory, and engineers report that there is sufficient water in the river to allow slack water navigation to Olean, N. Y.

THE MINNESOTA STATE DRAINAGE DITCHES, says the Minneapolis "Sunday Times," are from 30 to 40 ft. wide and from 4 to 10 ft. deep, according to local demands. The Red River Valley is extremely flat and about 225 miles long, by from 15 to 30 miles wide. About ten years ago this valley was carefully surveyed and a complete system of drainage planned, which is now being carried out under a State Drainage Commission, of which the members are Messrs. George R. Roberts, E. D. Childs and W. R. Hoag. The plans provided for about 275 miles of main ditches, at an estimated cost of about $750,000, or an average cost of $2,800 per mile. Thus far the State has expended $225,000 on these ditches, and of this sum the Great Northern Railway Co. has contributed $25,000. For economy the ditches are made smaller than the final plan calls for, erosion being depended upon to enlarge them to some extent. Under the law these ditches must be inspected by the Red River Drainage Commission before any payment is made for contract work. This Commission includes the Governor and Secretary of State, as ex-officio members, and also the Chief Engineer of the Great Northern Ry.

A STATE SEWAGE DISPOSAL COMMISSION has been appointed by the governor of Connecticut, in accordance with an act of the last legislature. The committee is to investigate the sewage disposal of cities, boroughs and towns and report to the next session of the legislature. All this is to be done without compensation. The members of the commission are as follows: Edw. H. Jenkins, of New Haven, Vice-Director of the Agricultural Experiment Station; John F. Cheney, of Manchester; John M. Woodruff, of Sherman; Robt. A. Cairns, City Engineer of Waterbury, and Fayette L. Wright, of Pomfret.

THE NATIONAL ROAD PARLIAMENT was convened at Nashville, Tenn., Sept. 16, with a goodly attendance from Alabama, Georgia, Kentucky, Michigan, Minnesota, Nebraska, Indiana, South Carolina and Virginia. No Tennessee delegates were present. Gen. Roy Stone presided. The delegates from the various states represented reported separately the progress made in their respective states. Among the questions largely discussed was the employment of convict labor in road building.

THE MOST SERIOUS RAILWAY ACCIDENT of the week is reported from Howard, Wis., on the Wisconsin Central R. R., Sept. 17. Two through freight trains met in a head end collision resulting in the death of five and the injury of three. The accident resulted from one of the trains which was seven hours late trying to make a siding before the arrival of the regular train.

ANOTHER RAILWAY ACCIDENT occurred Sept. 16 at Keytesville, Mo., on the Wabash R. R., in which four persons were killed and nine injured. A passenger train ran into a freight which had stopped preparatory to switching. Both trains had received orders to pass at Keytesville.

UNEXPLAINED RAILWAY ACCIDENTS are rather more common than is satisfactory to persons who desire to arrive at the reasons for all things. In many such cases investigation shows that any one of various causes might have produced the effect, or fails to show any definite cause whatever, the accident being simply inexplicable. An instance of this is the derailment on the Chicago & Alton R. R., noted in our issue of Sept. 2. In answer to an enquiry as to the cause of this accident, Mr. Willis E. Gray, General Superintendent, writes as follows:

I am unable to say what caused the derailment of our train No. 8 at Alton, on Aug. 29. The engine truck wheels were the first to leave the rails on a curve which has been recently re-tied and surfaced, and was in first-class condition. The engine truck wheels were steel tired and not flange worn. There was no evidence of anything having been placed on the track and the track did not spread.

THE JUNCTION HOLLOW BRIDGE, over the Junction Railway in Pittsburg and at the entrance to Scheuley Park, was the scene of an accident on Sept. 20. The bridge is being built by the Schultz Bridge Co., and consists of six steel arch ribs of about 350 ft. span. These ribs were built from the abutments towards the crown; and four filling pieces were in place and the two others were being lowered, when the falseworks gave way beneath them. As the two pieces fell they struck and wedged betwen the completed parts of the main ribs, while the falseworks under the other four ribs held. The two arch-fillers dropped about 4 ft. below their proper positions; but the contractors claim that no material damage is done as the falseworks can be replaced and the pieces raised to their proper place. No one was injured, though a dozen men were on the falseworks when the fall occurred. One report has it that the men knocked out too many of the blocks beneath the ribs and thus let them drop on the falseworks as they were attempting to put in the center pin.

A LARGE ENGLISH CONTRACT has, from all accounts, been awarded to the Westinghouse company by the Metropolitan Supply Co., of London. The various reports state that a lighting plant using three Westinghouse two-phase generators, of 2,000 HP. output, will be directly connected to Westinghouse engines of like power. The dynamos will, it is said, resemble in all particulars the four large machines now in course of construction for the Allegheny County Light Co. These have a field, which, including spools, etc., weigh 242,000 lbs., with an over-all diameter of 22 ft. 7 ins. The armatures weigh 40 tons. The approximate total cost is about $450,000, and the date of completion is given as July, 1898.

THE PEARY ARCTIC EXPEDITION, which sailed in July last for preparatory work for the main expedition of next year, is at Sidney, N. B., on its way home. Lieut. R. E. Peary, C. E., U. S. N., is bringing with him the huge meteorite discovered at Cape York and said to be the largest in the world. The expedition also brings back relics of the Greeley party left at Cape Sabine.

A PIGEON DISPATCH FROM THE ANDREE balloon expedition to the North Pole has been received at Copenhagen from Hammerfest, Norway. It was brought by the whaling ship "Falken," and is dated July 13, or two days after the start of July 11. It reads 12:30 p. m.; latitude, 82.2° North; longitude, 12.5° East. Good voyage Eastward; all well." As he was going Eastward, as intended, this dispatch would verify his reported arrival in Arctic Russia, or Siberia. On the other hand, aeronautic experts declare that his balloon could not have been seen in Siberia, about Sept. 1, as it could not remain in mid-air over 12 days.

EXAMINATIONS FOR A TOPOGRAPHICAL DRAFTSman will be held on Sept. 21, and for Superintendent of the Harlem River Driveway on Sept. 24, both at 10 a. m., by the New York City Civil Service Commission, at the new Criminal Court Building.

THE STEAMSHIP "KAISER WILHELM DER Grosse," of the North German Lloyd Line, due in New York on Sept. 25, made an average of 20.7 knots from Bremen to Southampton, with 68 revolutions per minute. At one time, off East Goodwin, she made 25.1 knots with 74 revolutions per minute. Her builder guaranteed 21 knots at a minimum of 75 revolutions. This new steamer is 648 ft. long, 66 ft. beam, 43 ft. depth, and has a displacement of 20,000 tons, with a carrying capacity of 14,000 tons. She has two triple expansion engines, with cylinders of 52, 80¾ and 96½ ins. diameter, there being two low-pressure cylinders. The two propellers are three-bladed, 22 ft. 3¾ ins. diameter, with a pitch of 32 ft. 10 ins.; they are made of bronze and weigh 26 tons each.

EXPERIMENTS WITH THE SYNCHRONOGRAPH, recently conducted in England by the inventors of the system, Messrs. Squires and Crehore, are reported as very successful. In a test made Aug. 22 over a line from London to Aberdeen and return by underground cables, messages were sent at the rate of 4,300 words per minute. In another test, a submarine cable 120 knots long, was employed. Messages were transmitted in this case at the rate of 1,300 words per minute.

THE LARGEST MULTIPLATE STATIC MACHINE ever constructed was recently tested by its builders, Messrs. Waite & Bartlett, 147 E. 23d St., New York city. This machine is enclosed in a glass and oak case $11 \times 5 \times 9$ ft. high, made practically air tight by rubber gaskets. It is constructed after the well-known Holtz type, using eight ⅜-in. plate glass plates, 60 ins. in diameter. These are mounted upon a 4-in. steel shaft supported in turn by roller bearings. The plates alone weigh nearly 1,000 lbs. and will, when the machine is set up finally, revolve at the rate of 250 per minute. A Toepler-Holtz machine in one corner serves as a separate or initial exciter. Under favorable conditions a 30-in. spark can be obtained, while the low humidity of summer limits the striking distance to about 24 ins. The machine will be taken apart and shipped to Washington, D. C., where the owner, Dr. F. A. Gardner, will use it in therapeutic work.

THE PRUSSIAN STATE RAILWAYS, says U. S. Consul J. C. Monaghan, of Chemnitz, play an important part in the state finances. The receipts for 1895-96 were $247,381,970; and in 1896-97 these will doubtless reach the budget estimate of $264,230,000. How important is this railway revenue can be best appreciated by noting that the total income of the government is $476,000,000. The railways pay over one-half of this; direct and indirect taxes pay $55,911,000; mines and smelting works owned by the state pay $30,226,000; forests and lands pay $21,658,000. The net gain or surplus from railway operation was estimated at $103,768,000 in the last budget. The tendency now, all over the German Empire, is towards state ownership of all transportation facilities, and also of telegraph and telephone communication, says Mr. Monaghan.

THE NEW YORK STATE CANALS IMPROVEMENT.

III.

(With two-page plate.)

Methods of Work.

Unlike the Chicago Drainage Canal, very few novel and costly machines for excavating and conveying earth and rock were required for the New York State canals work. In most cases not more than 2 ft. of excavation had to be done, and this was performed by dredges and steam shovels to some extent, but mostly by hand. To take away the spoil, wheelbarrows, teams and locomotives and cars proved amply sufficient. It is plain, therefore, that very few special machines and methods need to be described, and that this article must confine itself to the discussion of methods for doing such work which are more or less familiar to all engineers. In the preceding articles the work to be done has been described quite fully.

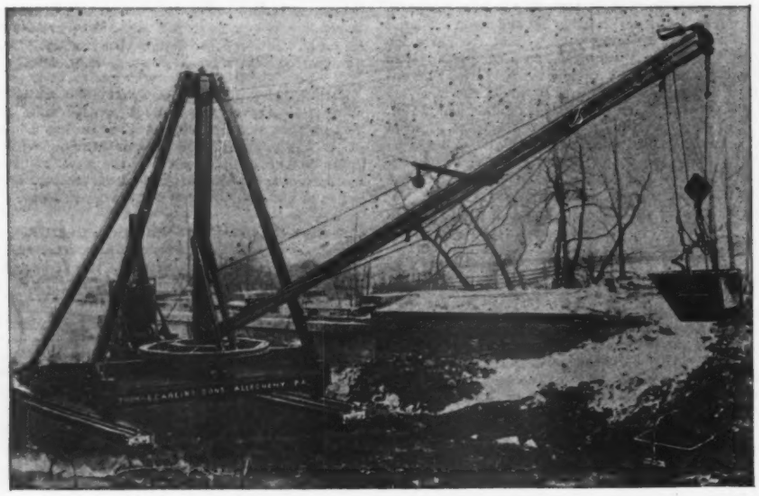


FIG. 16.—SINGLE DERRICK PLANT FOR HANDLING EARTH.
John Dunfee & Co., Utica, N. Y., Contractors.
Thos. Carlin's Sons, Allegheny, Pa., Builders.

Drying the Channel.—As stated in a previous article part of the deepening of the canal prism was required to be done dry and part had to be done under water. Where dry excavation was required the first work was, of course, to pump the water from the channel. This was generally done with centrifugal pumps after building coffer dams, dividing the canal into convenient sections. Practically the only features of this work worthy of note are the construction and maintenance of the coffer dams.

The type of coffer dam used by the Buffalo Dredging Co. consisted of two rows of piles filled between with clay puddle. The piles of each row were spaced 8 ft. apart c. to c. and connected with waling strips, inside of which was driven a sheeting of 4-in. timbers. The two rows of piles were spaced 10 ft. apart. The dam was carried straight across the canal and extended into the banks about 10 ft. For rock bottom the Donnelly Contracting Co. had good success with a dam made of triangular-shaped bents, planked on the sloping side. Three bents were connected and sunk by means of pockets filled with stone, and then three more, until the channel was spanned. Like the puddle dams just described, these dams were built straight across the channel. A V-shaped dam was used by Charles F. Parker & Co., consisting of two rows of close sheeting, driven to waling and buttressing into the banks. The space between the sheeting was filled with puddle. Various modifications of these forms of coffer dams were used at the other points on the canal.

Dry Excavation, Earth.—On all except a few contracts dry earth excavation was done with picks and shovels, and the material loaded into wheelbarrows and wagons. Inclined roadways were built of timber or earth, by means of which the men and teams entered and left the canal. It will be readily understood by engineers that for skimming off the foot or less of soft material on the canal bottom these simple methods would often be more advantageous than any elaborate system of mechanical excavators and conveyors. In a number of instances, however, special excavators and conveyors could be used to advantage, and they were adopted.

Fig. 14 shows the method of excavation adopted by the Furnaceville Iron Co., subcontractors under Donnelly & Co. The earth is excavated by pick and shovel and loaded into skips handled by revolving derricks. Two derricks were used at each face, one placed on the berm and the other on the canal bottom between the walls. The derrick on the berm raised the skips within its reach and dumped them over the berm bank or into cars according as the material was to be wasted on the bank or had to be carried to some other place. The duty of the crane on the bottom of the canal was to lift and swing the distant skips within reach of the berm derrick. The illustration shows the method of work quite clearly, and is also interesting as showing the side wall masonry and the distribution of the silt deposit which had to be excavated.

A somewhat different method of revolving derrick excavation was adopted by Gallo & McNiece, and is shown by Fig. 15. Here the derrick boom was long enough to enable the machine to be placed on the canal bottom close to the side wall and to dump on the spoil area on the adjacent bank. The excavation was done by pick and shovel, and the spoil loaded into skips.

Derricks somewhat similar in operation were used by John Dunfee & Co., who had about 15 miles of work west of Syracuse, N. Y., comprising contract sections 3, 4 and 5 of the Middle Division. On contract 3 the traveling derrick shown by Fig. 16 was used. This derrick was built by Thos. Carlin's Sons, of Allegheny, Pa., and consisted of a car or platform of 20-ft. gage, with double flanged wheels under it, the platform being 28 ft. long, made of heavy timbers, and all being floored over with 3-in. plank. The derrick proper consisted of a mast 25 ft. high and a boom 62 ft. long. The mast was guyed sidewise, by means of an "A" frame; the mast resting on the base timbers of this frame so that by moving the boom the whole derrick could be lowered to go under bridges. The derrick base and the seat for the boom were separate castings, so that should the knee be broken it would not be necessary to take the machine apart to replace it. The engine for operating the derrick was 7 × 10-in., double cylinder engine, with a drum for raising the boom, another for raising the load, and two small drums for swinging the derrick, by means of a turntable which was attached to the mast. The hoisting and boom drums had pawls and ratchets with a brake for lowering the boom. The machine was moved ahead by means of the cat-head on a shaft placed ahead of the drums with its bearing on the main bed-plate of engine. Two back stiff legs or guys were also used on the derrick, which were hinged so that they could be moved when derrick was lowered. The whole machine was placed in the bottom of the canal, and the track consisted of 6 × 12-in. hemlock

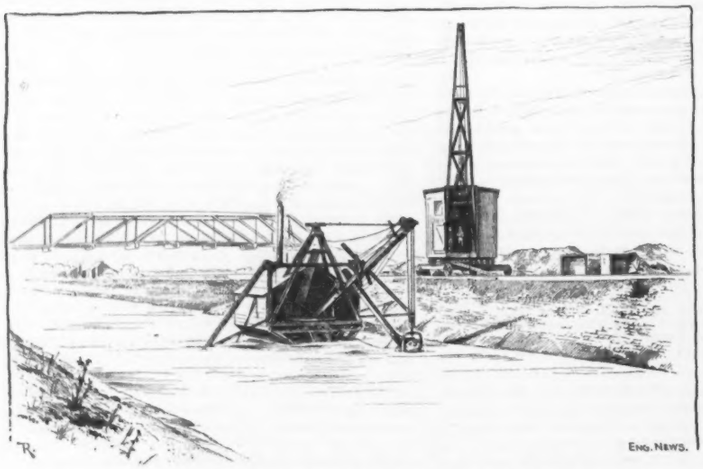


FIG. 17.—LAND DREDGE HANDLING EARTH IN SLIGHT DEPTH OF WATER.

FIG. 24.—DRIVING PILES TO SUPPORT SIDE WALLS.
Buffalo Dredging Co., Buffalo, N. Y., Contractors.

stringers with 56-lb. rails 12 ft. long, with splice bars and bolts. It was found necessary in some places to plank or floor over the canal where quicksand was met.

On contract 4 a derrick was used which ran on a track along the canal bank and had a boom long enough to reach half way across the channel. It

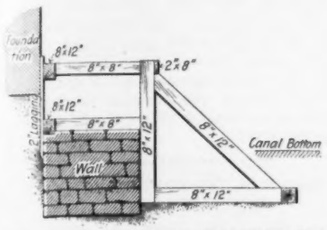


Fig. 18.—Sketch of Bracing to Hold Sliding Banks. McDonald & Sayre, New York, N. Y., Contractors.

was used first on one side of the canal and then on the other, removing half of the material in each position.

Fig. 17 shows a system of excavation adopted on one of the "dry" sections, which was, however, really excavated in a slight depth of water. This excavator was of the steam shovel type and rested on the bottom of the channel. It loaded into skips placed on a scow, and as each skip was filled it was lifted and dumped by a revolving derrick placed on the adjoining bank.

Besides the systems of dry excavation described, cars loaded by steam shovels and hauled by locomotives were used by a number of contractors. Generally the tracks were laid along the bottom of the canal and inclines constructed by which the trains ascended to the berm. One of the largest plants for steam shovel work was used by T. J. Dwyer & Co., near Utica, N. Y. This firm had 3½ miles of work, and about 57% of the excavation was earth. Three Barnhart steam shovels with 1½ cu. yd. dippers were used for excavating, and the spoil was handled by three locomotives and 100 cars. Locomotives and cars were also used by McDonald & Sayre, who had 4.94 miles of the work in the vicinity of Syracuse, N. Y. About 10% only of the excavation was rock. Tank locomotives and side dumping contractors' cars were used. This firm had some difficulty in supporting buildings located close to the canal owing to the unstable nature of the soil, which was a laminated clay dipping toward the canal. The method of bracing, which proved most efficient for holding the banks in place, is shown by the sketch, Fig. 18.

Dry Excavation, Rock.—About the only difference in the excavation of earth, and rock dry consisted in the channeling and blasting necessary to get the rock into shape to be loaded. All the methods except steam shovels used in excavating earth were used in excavating rock also. Fig. 19 shows the incline and team method used on a portion of the contract of Donnelly & Co., in the city of Buffalo, N. Y. The illustration shows the various processes of the work quite clearly. In the far distance the jets of steam vapor show the steam drills at work. The electric drills are located in the vicinity of the two inclines. On the smooth patch of rock near the first incline will be noticed the wooden pegs which temporarily fill the drill holes and indicate very clearly the proximity and arrangement of the blasts needed to break the rock into convenient sizes for loading by hand. Incidentally this view shows a rather curious piece of construction, other instances of which are found at various points along this part of the canal. The vertical wall on the left hand side is placed on longitudinal timbers which rest on smooth level rock. This wall and its foundation, it is necessary to say, is some of the original construction work of the canal, and it would be interesting to know just what purpose the engineer had in mind in placing this cushion of wood between the masonry wall and the rock foundation bed. Having always been under water, the timbers are of course as sound and stable as they were when placed.

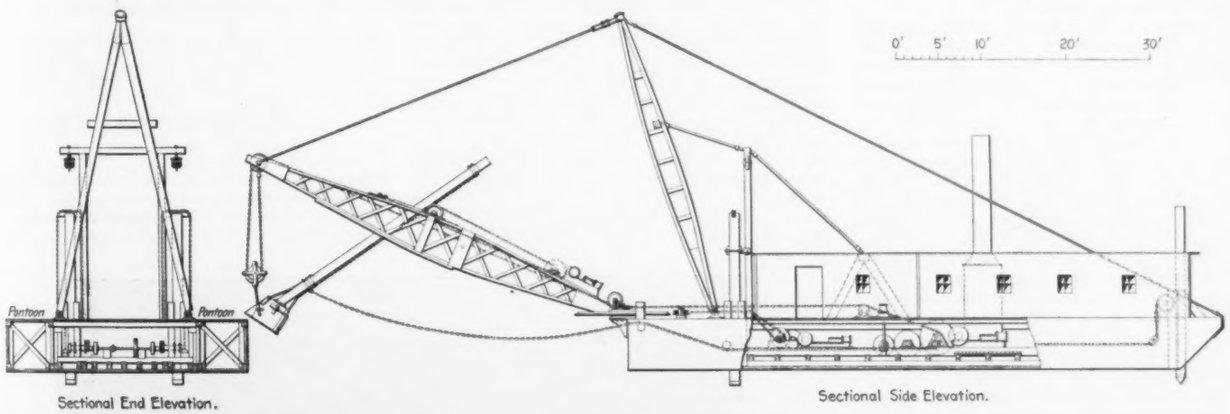
Fig. 20 shows a system of dry rock excavation used by the Furnaceville Iron Co., previously mentioned, where a revolving derrick dumps the broken rock into a train of cars running along the canal bank. The rock is first blasted, and then loaded by hand into skips. Fig. 21 shows the method of dry rock excavation adopted by Charles F. Parker & Co., on their contract near Lockport, N. Y. The rock is channeled and blasted and then loaded by hand into cars running along the two tracks shown on each side of the channel. These cars have detachable bodies and are hauled by horses to the cableways, which pick up the bodies and dump them on the spoil bank. The cableways were made by the Lidgerwood Mfg. Co., of New York, N. Y., and were modifications of the traveling cableways used so extensively on the Chicago Drainage Canal. Altogether about 116,000 cu. yds. of rock will be excavated by this method.

Wet Excavation, Earth and Rock.—Both earth and rock under water were removed by dredges, and the only difference that existed between the two classes of work was that the rock had to be blasted before it was dug. Fig. 22 shows the drill boat "Rand" used by the Buffalo Dredging Co., on its work between Buffalo and Lockport, N. Y. The hull of the "Rand" was 24 × 80 ft., and it was equipped with three steam drills of the "Rand" type, operated by 5½-in. steam cylinders and raised and lowered by hydraulic hoists. Fifteen 3-in. holes were drilled at each shift, and were blasted with dynamite without moving the boat.

The Buffalo Dredging Co. also had the largest plant of dredges used on the canal work. Its contract covered 22.2 miles of the Erie Canal, running east from Ferry St., Buffalo, to within about six miles of Lockport, N. Y., and comprised about 813,000 cu. yds. of earth, and 2,000 cu. yds. of rock excavation under water. The largest number of dredges used at one time was six. Fig. 23 is a view of dredge No. 2, which is, in a general way, typical of the larger dredges used. This dredge had a 28 × 90-ft. hull, 14 × 10-in. engine, 1¼-in. chain, and 2½ cu. yd. dipper for earth, and a 1¼ cu. yd. dipper for rock. The spuds were handled by steam cylinders, and an electric light plant was provided for night work. Two small dredges were used for working under bridges and in other places where space was limited. The larger of these dredges had a 22 × 50-ft. hull, 6 × 8-in. engine, 1-in. hoisting rope and a 1¼ cu. yd. dipper, and the smaller had a 17 × 50-ft. hull, 5 × 6-in. engine, ¾-in. hoisting rope, and a ¾ cu. yd. dipper. These dredges all loaded into scows which were towed about two miles to a point on the Niagara River, where the contractors had the right of dumping.

The existence of old pile and timber-work at the sides of the channel at various places in Buffalo, and the necessity of reinforcing the side walls in other places before dredging about their foundations, made the pulling and driving of a great number of piles necessary. Fig. 24 shows the special pile-pulling scow used, and Fig. 25 is a sketch of the pile-driver in operation. The views indicate clearly enough the construction of both machines.

On the Eastern Division, about four miles of excavation through the village of Ft. Plain, N. Y., was also done with a dredge. The contractors for this work were Brumelkamp, Lane & Co., of Syracuse, N. Y., and the dredge was built by the Osgood Dredge Co., of Albany, N. Y., especially for the canal work. Fig. 25a. shows its construction quite clearly. As will be seen, the hull is made up of three sections, the two side sections being pontoons which are removed when the dredge passes through a lock. With the pontoons, the dimensions of the hull are 70 × 17 × 6 ft., and the width is reduced 6 ft. by removing the pontoons. All the machinery is mounted on the middle section of the hull, and it consists of an 8 × 10-in.



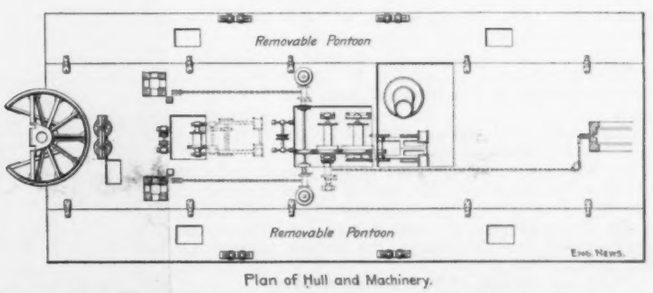


FIG. 25a.—SPECIAL DREDGE FOR NEW YORK STATE CANALS IMPROVEMENT.
The Osgood Dredge Co., Albany, N. Y., Builders.

double cylinder main hoisting engine, a 6 × 8-in. double cylinder, reversible, compound geared swinging engine, and a 5 × 6-in. double cylinder, reversible, compound geared crowding engine. A steel boom 45 ft. long is carried by an A-frame hinged at the bottom. This frame can be lowered

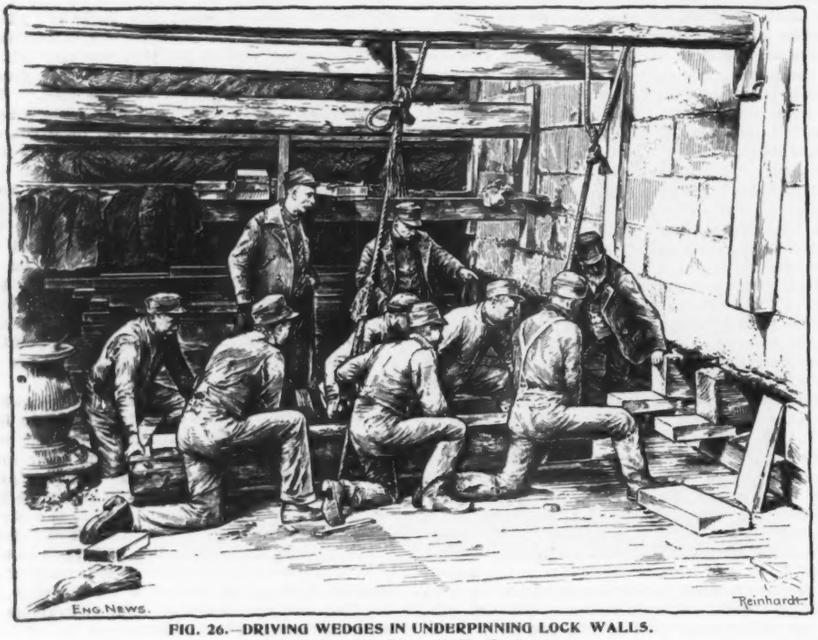


FIG. 26.—DRIVING WEDGES IN UNDERPINNING LOCK WALLS.
T. J. Dwyer & Co., Utica, N. Y., Contractors.

to permit the dredge to pass under bridges. The dipper is 1¼ cu. yds. capacity.

The feature of this dredge, which specially adapts it to the canal work, is the use of a crowding engine to control the dipper. By its use the dipper makes a practically level bottom for the whole width of the canal at one cut, and, when dumping, it thrusts the dipper so far beyond the end of the boom as to enable the machine to dump 52 ft. from its center, which is enough to dump clear over a towpath 18 or 20 ft. wide. The result is that there is little or no cleaning up to be done after the machine has passed, as it completes the work as it goes. The normal speed is one dipper full every 45 seconds, but it has been run for considerable periods at the rate of two dippers per minute. The builders state that the dredge has power enough to dig hardpan, bowlders and the softer grades of shale rock. They also state that under favorable circumstances it has dug over 1,000 cu. yds. per day, and that the average performance has been about 700 cu. yds. per day. It burns about one ton of soft coal per day and is handled by a crew of four men. Except in the narrowest portions of the canal, the dredge does not have to stop working for boats to pass, and in case of passing boats grounding, it is provided with powerful steam capstans to pull them off and help them past.

Deepening Locks.—The method specified by the State Engineer for deepening the locks and underpinning the side walls was described in the preceding article. On the whole, this method proved very efficient. To give an idea of the manner of bracing the side walls, and to show a very efficient extemporized ram for driving the wedges, Fig. 26 is given. This sketch shows the work on Lock No. 6, on the contract of T. J. Dwyer & Co., of Utica, N. Y. As the specifications required that no lock masonry or concrete should be laid with the temperature at or below freezing, a roof was generally built over the lock chamber and a stove placed inside. In some instances where the necessary current was available, electric lights were placed in the lock chamber and work carried on by night.

Culvert Building.—This work usually consisted in rebuilding the entire culvert. On the Western Division of the canal, between Ferry St., in Buffalo, and a point about 6 miles west of Lockport, N. Y., three culverts were rebuilt, and a description of this work will answer for other culvert work as well. The largest of these culverts carried the State Ditch underneath the canal to the Niagara River, and consisted of six 3 × 4-ft. wooden boxes placed side by side. It was replaced by six lines of 72-in. pipe. The old outlet of the State Ditch was first closed by a cofferdam and the water carried across the canal through a 6 × 15-ft. flume made of 2-in. planks, and supported on pile bents spaced about 6 ft. apart. The sides of the flume were braced together by ¾-in.. rods at the top and bottom, and were further supported by 12 × 12-in. uprights. The old wooden boxes and their foundations were removed, and a new and deeper foundation bed excavated, using wheelbarrows loaded by hand. A new foundation, consisting of long timber mud sills, was then laid for the iron pipe. The abutments in which the iron pipes terminated were of concrete as far up as the tops of the pipe, and of masonry above. Fig. 27 shows the abutment masonry at the intake end of the State Ditch culvert.

The two other culverts mentioned above were located at Three-mile and Cornelius Creeks. At Three-mile Creek a 3 × 4-ft. timber box was replaced by a single 48-in. pipe, and at Cornelius Creek six rows of 6 × 4-ft. timber boxes were replaced by four lines of 60-in. pipe. Except that at Three-mile Creek, no diverting flume was built, the method of constructing these culverts was the same as that used at State Ditch, already described.

Conclusion.—For the information from which this and the two preceding articles have been prepared, we are indebted particularly to Mr. Herschel Roberts, Deputy State Engineer and Surveyor, Mr. J. L. Little, Division Engineer, Western Division, and to the various contractors and builders of machinery whose names have been already mentioned.

THE DESIGN OF THE COAL BIN AT THE PATERSON ELECTRIC LIGHT STATION.

In our issue of Aug. 26 we described as fully as the date available permitted, the failure of a large coal bin at the electric power station of the Edison Electric Illuminating Co., of Paterson, N. J.

We are now able to present to our readers a statement regarding this bin from Messrs Milliken Bros., the designers and builders of the structure. We may preface it by stating that this information was furnished for publication at our special request and in response to our representation that the accident had called general attention to the proper methods for the design for large coal bins, and that engineers generally would be interested to learn the methods which were pursued in the

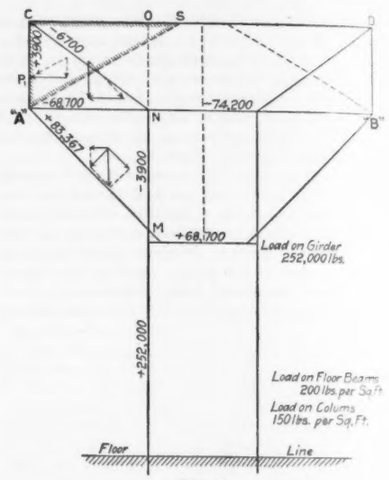


Fig. 1.

FIG. 27.—INTAKE END OF STATE DITCH CULVERT, NEAR BUFFALO, N. Y.

design of this particular structure. We believe Messrs. Milliken Bros. are entitled to much credit for making this information public, for the benefit of the profession. Their letter is as follows:

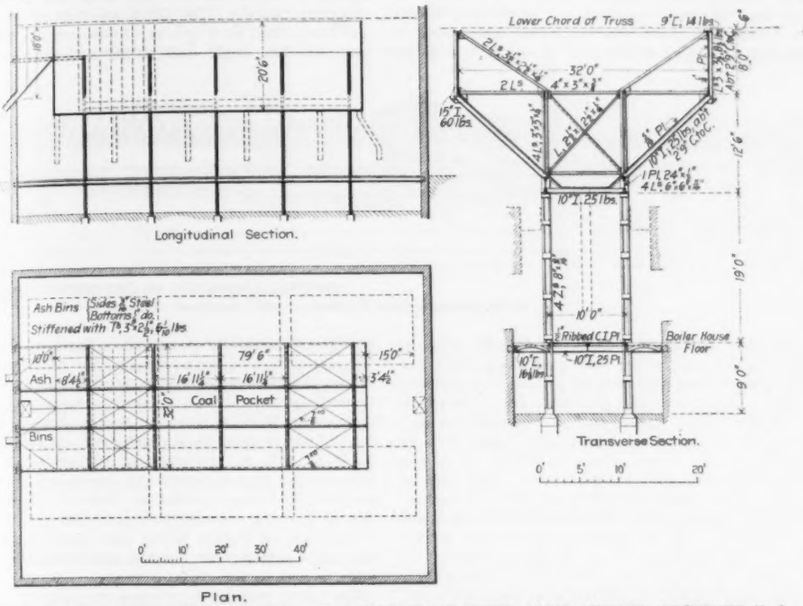
Sir: After receipt of your letter of Aug. 24 and our answer to you that we should be pleased to furnish you with certain information relative to the design and sections used in the Edison Electric Illuminating Co.'s coal pocket, at Paterson, N. J., we were much surprised to read in your issue of Aug. 26 an article in relation to this accident, in which, we regret to state, a number of statements made as facts are not correct, and the conclusions reached

We have had a sample piece cut from the 4 x 3 x ⅝-in. angle and tested to destruction by one of the well-known testing departments in this city, and their report shows that the ultimate tensile strength of this steel was 80,650 lbs. per sq. in., that the elastic limit was 51,910 lbs. per sq. in., that the elongation was 21.75%, and that the reduction of area was 42.91%. We trust that this information will be of interest to your readers.

Yours very truly, Milliken Bros.

39 Cortlandt St., New York, Sept. 4, 1897.

As respects Messrs. Milliken Bros.' objections to our previous article, we may remark that it was



PLAN AND SECTIONAL VIEWS OF COAL BIN FOR EDISON ELECTRIC LIGHT STATION, PATERSON, N, J.

are not correct. The tenor of the whole article seems to reflect on Milliken Bros. as being responsible for this accident. We think you will agree with us that it is not usual for "Engineering News" as a technical paper to pass an opinion, or attempt to pass an opinion, on the strength of a structure without knowing anything about the loading, the sections, or the capacity, and to pass their opinion on the subject, especially when the full information has been offered to them.

We now beg to state to you that our calculations for this pocket were based on the pocket sustaining 969.3 gross tons of coal (that is, 2,240 lbs. = 1 ton), assuming that 1 cu. ft. of coal weighs 58 lbs. We send you herewith a copy of our drawing card 6,402, which was submitted with our estimate and formed a part of our contract with the Edison Co., and in accordance with which the pocket was constructed. The pocket was designed for the coal to be leveled off on the top of the pocket.

From the article in your issue of Aug. 26 we understand that you wish certain information relative to the strain in the tie running across the pocket at each one of the 17-ft. bents. We give you herewith a copy of the strain sheet from which our estimate was made, marked "Fig. 1," based on the coal being leveled off on top of the pocket, and the coal being assumed as a mass acting vertically for that portion of the coal below the horizontal tie marked "A B;" and for that mass above the tie and to the top of the pocket, it was assumed to have a thrust in a horizontal direction. This is the usual method in everyday practice for figuring coal pockets. The horizontal strain, therfore, on this member, when the pocket was loaded level on top, would be 74,200 lbs. The member was composed of two 4 x 3 x ⅝-in. angles, out of which is deducted two rivet holes, giving a net section of 4.3 sq. ins., which would give a strain in this member of 17,256 lbs. per sq. in.

For the purposes of calculation (Fig. 2) we have further assumed that the pocket was filled with a little more coal than we originally calculated on; that is, 984 tons instead of 969 tons, and we have calculated the coal as acting horizontally for its full depth. In other words, as far as the horizontal thrust is concerned, we have considered the pocket as having the entire sides vertical, as shown in dotted lines, instead of being beveled off as it was actually constructed, and further, that the angle of repose of the coal is 30°, while in fact it is 34°, all of which calculations will tend to increase the strain in the horizontal tie and make it more than it really is.

In making this calculation we have used Rankine's formula. By this method you will notice that the maximum strain in the tie in question is 99,100 lbs. As the bar has a net sectional area of 4.3 sq. ins., we therefore get the ultimate strain in this bar of 23,047 lbs. per sq. in.

not our intention in that to do more than state such facts as were then ascertainable, and we explicitly said in it that any conclusions as to the cause of and responsibility for the accident would have to be deferred until more data were available.

With the information given by Messrs. Milliken Bros., however, it becomes possible to form an idea as to the strains which existed in the several members, and the course of events at the time of the accident. It will be remembered that in our former article we stated that an inspection of the wreck pointed out the member "A B," as probably the one in which failures originally occurred. This appears to be confirmed by the detail section and the strain sheets accompanying the above letter. The columns were amply strong, as their behavior in the wreck showed. The sides were also of ample strength. The horizontal member which tied the two sides of the bin together, however, had to take the thrust due to the pressure on the sloping sides, and appears from the figures given in the detail drawings to have been pretty light for the load placed upon it.

Reviewing now the assumption on which Messrs. Milliken state their design was based, it will be noticed that the bin is assumed to be even full and not heaped. Perhaps this was done because the purchaser called for a bin to hold a given quantity; but it seems clear to us that in figuring the strains on any such bin, the greatest load that can be placed in it should be assumed. If a man orders a coal bin designed to hold a thousand tons he would seldom hesitate to put into it all it would hold without overflowing, no matter what the weight, if he desired for any reason to accumulate so much.

Perhaps some of our readers may be confused by the idea that because the added mass produced by heaping the bin does not rest against the sides, it therefore produces no pressure tending to force them apart. The fact is, of course, that the weight of this mass is transmitted to the coal below which does rest against the sides, and this increases the pressure upon them.

The assumption made for the weight per cu. ft. of coal is certainly a fair one. Different authorities give the weight of a cubic foot of soft coal, broken fine and shaken moderately, at from 53 to 60 lbs. The value taken above is 58 lbs. We have taken pains to repeat the calculation of the weight of the even-full bin using this figure and obtain 984 tons, as given by Messrs. Milliken Bros.

Taking up now the methods by which the horizontal thrust of the mass of coal was computed, by Messrs. Milliken Bros., as the description of the methods given in the letter above is not as full as some of our readers may desire, we will endeavor to explain it more in detail.

Taking up first Fig. 1, the strain sheet on which the original estimate was based, we understand from Messrs. Milliken Bros., that the portion of the bin below the tie member "A B" of the bent was regarded as a dead weight resting upon the sloping side and bottom. The inclined side was

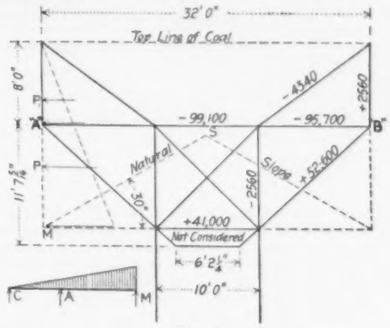


Fig. 2.

considered to have no effect on the tie "A B" other than that due to the horizontal component of the vertical load of coal upon it, as shown by the small diagram of forces. To find the total tension this was added to the side thrust due to the portion (c A s) sliding down the plane (A s).

The second calculation, of which the results are shown in Fig. 2, was made as follows: The bin was regarded as having vertical sides from top to bottom, as shown by dotted lines, and as filled level with the top.

The Rankin formula mentioned:

$$P = \frac{w x^2}{2} \cdot \frac{1 - \sin \psi}{1 + \sin \psi}$$

gives the total pressure (P) against a vertical side when w is the weight of a cubic foot of the material, x the depth and ψ the angle of repose.

It will be noticed that the assumptions made in both Fig. 1 and Fig. 2, are quite different from the actual conditions existing in the bin. In the latter case, at least, the idea of the designer evidently was to assume loads considerably beyond the actual, in order to be on the safe side.

In another column of this issue we have discussed the general problem of the computation of strains in bins of this type, and have endeavored to make assumptions which should conform as closely as possible to the conditions actually existing, which certainly should be done if designers are to err, neither by wasting material or by erecting unsafe structures.

The tests of the material of the tie submitted by the Messrs. Milliken show a steel of high tensile strength, which, under the most recent ideas of structural steel experts may be given somewhat higher unit strains than those which have been commonly used with very soft steel.

We believe, however, that it is generally agreed that increased care and better workmanship is a necessity in the use of these higher carbon steels, and such refinements as reaming or drilling of riveted holes are advisable if the higher tensile strength of the metal is to be relied upon. It may be questioned also whether it is wise to use such higher unit strains in ordinary riveted structural work of small dimensions where angles are used as ties and no especial care is taken to avoid connections eccentric to the axis of a member.

A proof of the above article was submitted to Messrs. Milliken Bros. after it was in type, and they have made the following reply:

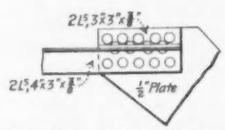
Dear Sir: We beg to acknowledge receipt of your letter of the 20th inst. enclosing us a proof of an article which you

intend inserting in your issue of Thursday, Sept. 23, relative to the failure of the coal bin of the Edison Electric Illuminating Company, at Paterson, N. J.

In the first place, we wish it understood that not only was the shape of the bin and its dimensions given us, but the capacity of coal that would be stored in the bin was also given to us by the Edison Company before we made any estimate on the work, and that filling the bin level on top would give approximately the exact number of tons which they wished to store, and in our proposal it was distinctly stated that the coal was to be level on top and the capacity of bin was given as 963.3 gross tons, in addition to which the net tonnage was given and also the number of cubic feet.

You state in your article that "it appears from the figures given in the detail drawing to have been pretty light for the load placed upon it," referring of course to the tie "A B." We call your particular attention to the fact that the strains in Fig. 1 give a factor of safety for this member of 4.62, and the revised strain sheet, Fig. 2, gives the factor of safety for the same member as 3.5. Either one of these factors we consider ample for building purposes, where we have to deal exclusively with static loads. In confirmation of this statement we would refer you to any number of authorities; for instance, to the report on the Thames River bridge, in which "the unit working value of the proposed steel was taken as near as may be at one-quarter its elastic limit for all live load and one-half its elastic limit for all dead load, or 10,000 lbs. and 20,000 lbs. per sq. in. respectively." If we allowed one-half of the elastic limit we would have used 26,000 lbs. Again, allow us to refer to Mr. Morison's paper on the Memphis bridge: "The tension members were proportioned on the basis of allowing the dead load to produce a strain of 20,000 lbs. per sq. in." These references that we have made are only those that we happen to have at hand convenient, and we could refer to many others. You will note, of course, that these two references that we have made refer to bridge work, and not to building work, the latter as a rule being taken at a less factor of safety than railway bridge work.

Further, the last clause of your article with reference to the angles states that "no special care was taken to avoid connections eccentric to the axis of the member." This is not at all correct. The vertical leg of the angles was



Sketch Showing Details of Gusset Plates at A and B.

riveted to the gusset plate, and the horizontal leg of the angle was reinforced by an angle 1 ft. 3 ins. long, riveted to the plate and riveted to the horizontal leg of the angle, so that the angle was fully connected. We enclose herewith a sketch taken right from the detail shop working drawings. Yours very truly, Milliken Bros.

THE WILLIS AVENUE BRIDGE OVER THE HARLEM RIVER, NEW YORK CITY.

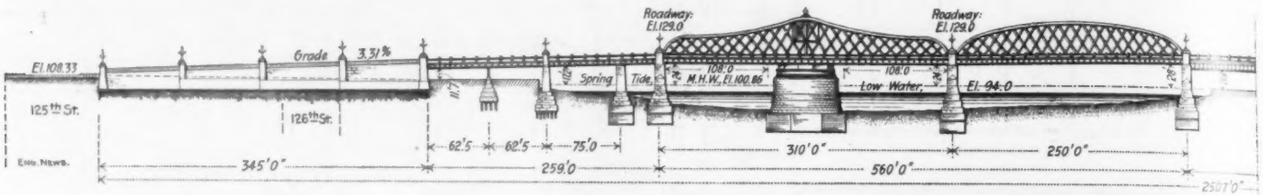
We present herewith an elevation of the new Harlem River Bridge, the contract for which was let on Sept. 16 to Leonard Foley & Co., 407 Harrison Building, Philadelphia, Pa., for $1,026,684. An itemized list of bids will be found in our Construction News Department.

The bridge will connect First and Willis Avenues, New York city, and will, owing to the relative positions of these streets, cross the river nearly at right angles. The clear width is 60 ft., and the total length 2,507 ft., distributed as follows: Starting from the intersection of 125th St. and First Ave., the roadway rises with a 3.31% grade upon a stone incline 345 ft. long. This grade is continued for the next 259 ft., but is a steel girder construction supported by stone piers. In this section the roadway curves 30°. The swing draw covers the next 310 ft., and this, together with a single truss of 250 ft., spans the river proper. The following 664 ft., crossing the yard of the New York, New Haven & Hartford R. R., is an elevated steel structure with a 1.77% upgrade supported upon six stone piers. Here again the roadway curves 30°, bringing it parallel with the First Ave. approach. A level section 104 ft. long and a viaduct 375 ft. long, with a 1.04% grade, brings the bridge to the Willis Ave. approach, which is a stone incline 200 ft. long, with a 3% grade.

The entire roadway, excepting the deck spans and viaduct, will be asphalt on buckle floor plates. The floor of the approaches will be granite blocks on concrete foundations, while the sidewalks of through and deck spans will be asphalt, and the approaches bluestone. Pile foundations will be used for the approaches and land piers, while the river foundations will rest on yellow pine caissons sunk by the pneumatic process. All stone-work above ground or water, such as approaches and piers, will be granite, while that below will be limestone. The draw, which is 310 ft. long, will rest on a roller hub at the center, and will be opened by machinery placed in an elevated engine-room over the roadway at the center of the span. In this house will be placed: two 60-HP. return tubular boilers, built for a working pressure of 100 lbs.; two 10 × 7-in., oscillating engines separately coupled by differential gearing, with a reduction ratio of 19 to 1 for operating the draw—the object of the duplex plant being obvious. For lighting the bridge a vertical high-speed engine of 65-HP., at 300 revs. per min., drives a direct-connected multipolar compound wound dynamo of 50 K-W. capacity, at 125 volts. Suitable cables will lead down the pier through a device which will allow the span to swing, and across the river bottom to the lights on the approaches and viaduct. In all some 312 32-c. p. and 12 16-c. p. lamps will be used. The speed of opening the draw will be 3 ft. per sec., or 243 ft. in 81 secs., while the end supporting cylinders require 15 secs., making the total time 96 secs.

To provide for every contingency, two sets of hand turning gear will be provided to operate from the deck of the draw. The draw will be centered, the load thrown upon the end piers by suitable raising and locking devices, operated by means of two hydraulic cylinders through rods placed at the ends of the span. These cylinders will have a power of 175 tons with the fluid under a pressure of 2,000 lbs. per sq. in., to maintain which a pump and receiver tank will be placed in the engine-room.

It is further provided that work must commence within 10 days of the time the contract was signed, and be completed within 500 days. We are indebted to Mr. G. W. Birdsall, Chief Engr., Croton Aqueduct, and Mr. Thomas C. Clarke, Consulting Engr. for the city in the erection of the Willis Ave. bridge, for the drawings and information from which this description was prepared.



GENERAL ELEVATION OF THE BRIDGE OVER THE HARLEM RIVER, NEW YORK CITY.

G. W. Birdsall, Chief Engineer, Croton Aqueduct.

CLEANING STRUCTURAL IRON BY THE SAND-BLAST PREPARATORY TO PAINTING.

The ironwork of the 155th St. Viaduct, in New York city, immediately over the station of the Manhattan Elevated Ry., has been badly corroded by the action of the hot gases from the engines upon the paint on the trusses and the under side of the buckle plates. This ironwork was painted at the shop, and about a month after erection; and has received four coats in all in the four years since it was erected. But in every case this paint showed a decided tendency to scale off in an exceedingly short time, and the iron has been vigorously attacked by rust. The Department of Public Works has taken the matter in hand and is now experimenting with paint of various makes, having first constructed a tight wooden floor about on the line of the bottom of the trusses, and protecting the work from the engines beneath. Mr. E. P. North, Consulting Engineer of the Board of Public Works, was convinced, however, that the chief trouble in work of this character lies in securing a thoroughly clean surface for the reception of the first coat of paint; and experience has also proven that the ordinary wire brush will not clean iron in a satisfactory manner. He, therefore, concluded to try the sand-blast as a means of cleaning the iron of all corrosion, scale and paint, and in this way obtain an absolutely clean and uniform surface for the application of the new paint. Mr. M. E. Evans, of the Department of Public Works, was placed in immediate charge, and an arrangement was then made with Ward & Nash, of Boston, Mass., agents for the use of sand-blast machinery, manufactured by B. C. & R. A. Tilghman, of Philadelphia. The first-named firm supplied the machinery for this purpose, and sent it with Mr. John F. Honey, as the New York representative of the firm. The Department of Public Works pays all the bills and also pays a fair price for the experimental painting.

The plant employed includes two Ingersoll-Sergeant air compressors; one 10 × 10 ins., and the other 10 × 12 ins. These compressors deliver the air to a receiver of 30 cu. ft. capacity, located beside the compressors, and it is piped from there to another receiver of like capacity located on the trusses and alongside the sand-and-air mixers. The second reservoir was put in to eliminate the moisture which at times, and under humid atmospheric conditions, gives rise to much trouble by clogging the sand in the mixers. The mixer itself is a simple but efficient device. It is practically, a vertical iron cylinder, about 5 ft. high by 2½ ft. diameter, with two sheet-iron hoppers riveted to the sides near the top. Through the openings in these two hoppers is passed a stem within a hollow stem, each stem carrying a valve to close its respective hopper. Underneath the lower hopper is placed a third hopper, detached from the sides of the main cylinder, and connecting by a thin slit or opening, which can be regulated in size by a sliding plate and an outside lever, with a 3-in. pipe leading to the sand-blast hose, and open at the inner end of the pipe.

The operation of this mixer is as follows: Clean and very coarse silicious sand, obtained from Huntington Harbor, on Long Island Sound, is poured into the upper hopper of the mixer; by manipulating the stems mentioned, the valve of the second hopper is closed, and that in the upper one opened, and the sand passes to the second hopper, which is virtually an air-lock. On top of the lower valve stem is a weighted ball, and a tap on this overcomes the air-pressure from beneath and permits the charge of sand to pass from the air-lock into the third, detached hopper, from which it is fed into the air-pipe in a thin sheet. It should have been previously mentioned that air, compressed to 20 lbs. to the sq. in., is fed from the nearby receiver to the mixer by a 3-in. pipe, entering the side of the cylinder under the second hopper and near the top of the detached hopper. The compressed air circulates freely around this latter hopper, and, in actually passing out of the mixer, it enters the open end of the outlet-pipe, and, passing through the thin sheet of sand, carries this sand along with it.

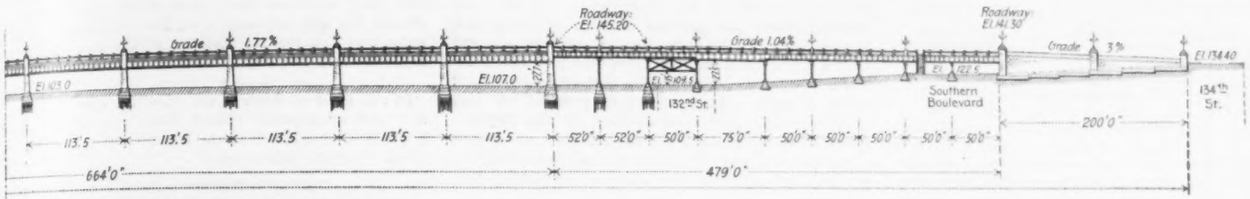
The sand and air, now thoroughly mixed, passes by a 2½-in. special, soft rubber lined hose to the

trusses, and the hose terminates in a chilled-iron nozzle, about 8 ins. long and 9-16-in. opening, for general work. This nozzle is rapidly cut by the abrading sand and has to be frequently changed. It has been calculated that the air leaves this nozzle with a velocity of about 1,150 ft. per second; but the velocity of the mixed sand and air, probably, does not exceed 250 to 300 ft. per second, owing to its greater weight and the sand friction in the hose. The hose and nozzle are manipulated by a workman, whose head is protected against the dust by a helmet with a gauze eye-piece; the nozzle, being usually held within about 8 ins. of the work, and normal to it in direction. The sand is crushed by the impact, but is gathered up from the floor and used four times before it is finally rejected. The action of the sand is rather that of a hammer blow than that of a cutting tool; it destroys the contact of the paint with the iron, and seemingly removes the paint in the form of minute scales. It should be said that before applying the sand-blast all loose scale is rapidly removed from the surface to be cleaned by the air-blast alone.

As to the work performed by the sand-blast, Mr. Evans states that, under the conditions existing at 155th St., about 80 sq. ft. per hour can be thoroughly cleaned of the rust, mill-scale and the four coats of paint which have been applied; and it may be mentioned that this paint comes off in four distinct layers, showing the lack of an intimate union between them. For average conditions of rust, about one-third of a cubic foot of sand is used per square foot of surface in a single operation. The cost of cleaning at this point is naturally somewhat excessive, as it is conducted under experimental conditions. At the beginning it amounted to about 20 cts. per sq. ft.; then fell to 13 cts., and is now under 10 cts. Mr. Evans believes that for about 600,000 sq. ft. of average viaduct surface, the machinery could be purchased, scaffolding erected and the work performed, with a fair contractor's profit, for about 7½ cts. per sq. ft. As thorough wire-brush cleaning costs from 4 to 5 cts. per sq. ft., and can in no way way compare in thoroughness with the sand-blast, the price named seems satisfactory.

In connection with the efficiency with which the sand-blast performs its work of cleaning, it may be said that it leaves an absolutely clean surface of pure iron, showing every pit made by corrosion, but with each pit thoroughly cleaned out. The sand-blast, too, cleans points among the truss connections which would be absolutely inaccessible to the wire-brush. One point that must be heeded in this sand-blast work, however, is the fact that the cleaned iron surface is very susceptible to oxidation, and if it is not at once covered by paint, a few hours' exposure to ordinarily humid air will result in a thin coating of the red oxide. For this reason the work of cleaning and painting is conducted almost simultaneously by the Department of Public Works. The sand-blast gang commences work at 6 a. m., and stops at 3 p. m.; and from 3 to 6 p. m. the painters cover with a priming coat all the surface cleaned in that day. When the entire 50,000 sq. ft. of surface under treatment has been thus cleaned and protected by one coat of paint, the final coats will be applied, the sand being first all cleaned away so that there will no longer be any flying dust. It is of much interest to note that from this surface of 50,000 sq. ft., 6½ wagon loads, of more than a ton each, of scale and dust lodged on the trusses were removed by the air-blast alone.

No less than 17 different firms are supplying the paints now being tested, the purpose of the Department being to try as many distinct types of paint as possible. Of course, none of the paints have been exposed long enough to give any idea as to their relative durability, but it is found that all of them appear to adhere to the clean iron surface with great tenacity, and the contrast is great between these paints and the paints which were applied over old paint. The firms supplying the paints now being applied are as follows: The American Lucol Co.; the Detroit Graphite Co., and Harrison Bros. & Co., all of New York; M. B. Suydam, of Pittsburgh, Pa.; Patterson-Sergeant Co., of Cleveland, O.; F. W. Devoe, New York; Edward Smith & Co., New York; Hedden & Wheeler, of Newark, N. J.; Goheen Manufacturing Co., Canton, O.; Assyrian Asphalt Co., Chicago; Chilton Manufacturing Co., New York; Sherwin-Williams Co., Cleveland, O.; Standard Oil Co., New York; Joseph Dixon Crucible Co., Jersey City; California Asphalt Co., New York; Standard Paint Co., New York, and The Powell Paint Co., of Syracuse, N. Y.



HARLEM RIVER AT WILLIS AVE., NEW YORK CITY.
Thos. C. Clarke, Past-President Am. Soc. C. E., Consulting Engineer.

THE DEVELOPMENT OF LAKE SUPERIOR IRON-ORES.*

By D. H. Bacon,† M. Am. Inst. M. E.

Down to late in the 50's the ore-product of Lake Superior was handled over a mule-tram-road to Marquette; now the Duluth, South Shore & Atlantic, the Chicago & Northwestern, the Wisconsin Central, the Duluth, Superior & Western, the Duluth, Mesabi & Northern, the Duluth & Iron Range and the Lake Superior & Ishpeming railroads serve the shippers. Down to nearly 1870 a 700-ton ship was an enormous craft, the unloading of which required two days; the unloading being seldom accomplished in that time. In 1871 the largest ore-barge carried 1,050 tons and made twelve trips per season. Now the cargoes reach 5,000 tons, the loading requiring less than three hours, and the unloading ten hours. Now the mines cover more land than was familiar to even the "timber-cruiser" when the Jackson mine was opened. The annual shipments have grown from a few thousand to 10,000,000 tons, and the ability of the mines to produce is not taxed. Lake-freights are at one-eighth, and rail-freights at one-quarter, of early prices.

The deeper waterways, commodious locks and large ships of to-day are in a greater measure due to the movements of ore than to any other cause. Great savings have been made in each detail of each department. The only item of cost that has not been lessened, I am glad to say, is the money paid to men. Wages, measured by what they will buy, are as high now as at any time past, unless it was a time of feverish activity.

As illustrating the cheapening that has been effected, ore is to-day sold at Lake Erie ports for one dollar per ton less than in early times it actually cost to mine it; and this is done without loss, and further economies may be expected. Young men remember sales of ore in Pittsburgh at $18 per ton, or about the present price of rails.

The first mines were opened in Marquette county and produced what is commonly known as "hard ore." Previous to 1873, "soft ore," or hematite, was not popular, but the buyer was often obliged to take some, in order to secure the needed quantity of hard ore. In those good old days, the ore-buyers came to the sellers as penitents approach a shrine, but I am told that custom in this respect has changed somewhat of late.

Beginning with a few grades, the Lake Superior mines now offer ores ranging from the purest and best to those that will not bear transportation; and within these limits can be found the varieties needed for general and special products, in quanity equal to any demand. The men who were early in charge of the mines had some knowledge of mining and quarrying. Many of their methods are now out of date; but experience, daily observation and study, technical schools and the mechanical ability common among Americans, have enabled those in charge to meet all difficulties and to carry the industry to a degree of perfection that is complimented by visitors from abroad. In the discovery of new fields, the miner of iron-ore, like the miner of more precious metals, has led the way; the explanation of the geology being left to the student.

As viewed from the distance, the early methods of mining were very crude. Horses furnished the power; and they were worked in all possible places. The little machinery then in use was poor and often but ill-adapted to the work. The first hoisting-plant of large size, economical design and capacity equal to future demands was set up at the Lake Superior mine in 1880. Now single, compound, triple and condensing-engines of large power are found throughout the iron-ranges for hoisting, pumping and compressing. The striking-hammer has been supplanted by the power-drill, and electric motors and rope-haulage are common above and below ground. Underhand, back and breast-stoping, square-sets, caving-sets, saddle-backs and milling-and-filling are common. Steam-shovels and locomotives have taken the place of hand-shovels and carts. Every known system has been or is in use. Many mines have presented difficulties that, in the early days, would have been considered insurmountable; but each has been overcome. To one closely identified with this industry for nearly 30 years, no single change has seemed important, and only by looking backward can one measure the advance. The early operators had little knowledge of ore-deposits, their position in relation to associated rocks, their dip, pitch, strike, depth and many other facts, an understanding of which is necessary to continued success. This knowledge has been acquired; and with it have come right courage, true economy instead of parsimony, the general development of ore-supplies far beyond immediate needs, and a thoughtful preparation for the future.

Nitroglycerine and power-drills have done more to reduce cost than any other two improvements. In 1871 a drift was driven at the Cleveland mine at a cost of $100 per foot. Now the cost would not exceed $16. In one case men were harnessed to a derrick-sweep. Heavy rains were nearly always followed by a few days of idleness and the pumps were expected to freeze every cold night.

In speaking of mining methods, I have mentioned the "caving system," which several claimed to have invented or introduced. The first ore taken out by this method was mined at the Cleveland hematite mine in 1883. The ore was very soft, with treacherous walls; and Mr. G. W. Wallace, the superintendent, tried what some of his men said was successful under like conditions in England. It proved satisfactory, and is now known as the "caving-system." Mr. John Pengilly was sent to the Cleveland hematite mine to learn the method, so that he might use it at the Brotherton mine.

The discovery and quick development of the Mesabi profoundly affected the iron and steel industry of this country; and the effect may extend beyond our shores. Each era of depression brings a reward in the better methods which are forced upon us, and which, continued into days of prosperity, increase the volume of business and to that extent the profits. With the low prices that are here to remain, it is more than ever difficult to estimate the annual consumption. Speaking of the several ranges as one, the acreage of known ore is but a small part of the area that may contain ore. Discoveries are still being made in the Marquette district, the exhaustion of which was expected 20 years ago. And I may say, in passing, that the known ore under the bed of Lake Angeline is four times as great as was all the known ore in all of the mines of that country at any time prior to 1887. The past few years have not been such as encourage prospecting; but given favorable conditions, we may confidently depend upon important discoveries. For 40 years this region has met all demands; its resources are to-day, as compared with demand, greater than at any time past; and I believe that those who are now active will have stepped aside and will perhaps have been forgotten before this region will fail as an adequate source of supply.

*A paper read at the Duluth meeting of the American Institute of Mining Engineers.
†Minnesota Iron Co., Soudan, Minn.

A PECULIAR BOAT was launched Sept. 8 at Toronto, Ont. This odd craft is known as the Knapp roller boat and consists of two cylinders, an inner one carrying all the machinery, supplies, etc., and an outer cylinder provided with paddles. The inner cylinder is supposed to maintain its position owing to the mass of machinery being below the centre, while the outer one revolves. In this way the vessel is supposed to progress by actually rolling over the water's surface. The total weight will be 100 tons, of which the engines and boilers make up 30 and the hull the remainder. The inventor expects to roll across the Atlantic in 48 hours.

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The refusal of Acting Secretary of the Navy Roosevelt to grant the request of Mr. A. G. Menocal, C. E., U. S. N., for a court of inquiry into his methods of conducting the repairs on the crippled Brooklyn dry-dock, seems to be both unjust and unwise. Had Mr. Menocal been given the practically unlimited power now conferred upon Naval Constructor Bowles, as the board of civil engineers recommended at the time of reporting upon the injuries to the dock, the delays complained of would probably not have occurred, and there would have been no occasion to transfer the work to another bureau. From the answer of Mr. Roosevelt, it is evident that the system of conducting work in the Bureau of Yards and Docks was so tangled in red tape that the Chief of the Bureau himself was uncertain as to what engineer really had charge of the repairs. The remark that since Mr. Bowles took charge "there has been an immediate and marked increase in speed," is insincere, and misleading; because this gain is solely due to the cutting of the red tape which bound Mr. Menocal. It was not due to a change in men or engineering methods, but to a more business like bureau management than existed before. The endorsement of Commodore Bunce, Commandant of the Yard, was to the effect that "the present system of purchase and procurement of supplies for the naval service is the cause of any complaint of slowness in the prosecution of repairs to the dock." Mr. Roosevelt says that this endorsement merely shows that the work should have been declared urgent by those having charge of it, and "especially by any officer whose attention was specifically called to the fact that there was need of urgency for the work." But the officer whose duty it was to recognize the necessity for and to order this urgent work was not Mr. Menocal, but it was Rear Admiral E. O. Matthews, Chief of the Bureau of Yards and Docks. Acting Secretary Roosevelt is punishing the wrong man for the neglect "to notify the Department" of the great emergency. Capt. A. S. Crowninshield, Chief of the Bureau of Navigation, specifically states that Mr. Menocal "discharged his duties in this case with efficiency and zeal"; and the Chief of the Department of Yards and Docks says, that at the time of the transfer, the work had reached a point where it would have been possible to proceed with it at a more rapid rate.

In view of these statements it seems that bureau organization—or disorganization, was responsible for the delay in conducting these repairs, and that Mr. Menocal, the engineer in charge, was powerless in the face of these entanglements. The fact that the ordinary regulations were relaxed by the Department, in the case of Mr. Bowles, was a direct confession that these stood in the way of speedy and satisfactory work, and had to be thrown aside before even Mr. Bowles could make the desired progress. Mr. Roosevelt has not only done an injustice to a reputable engineer, in denying him his right to show his actual connection with this work; but he has blundered in suppressing a court of inquiry which might have made the dry-rot methods of the Bureau of Yards and Docks, under the present manner of managing that bureau, so evident that a radical change would have been almost compulsory. The New York "Tribune" expresses the matter in a nutshell when it says that the greater part of all this trouble could have been avoided by the Department, if those in control had not been so greedy of power, and had permitted a competent civil engineer to be at the head of this Bureau of Civil Engineering.

Another of the perennial attempts to place the Philadelphia gas works in the hands of a private company is now being made, and will probably be as promptly defeated, when the opinion of its citizens makes itself felt, as previous attempts in the same direction have been. The latest offer for the gas works is made by the United Gas Improvement Co., which owns a large number of gas plants in smaller cities of the country, and is alleged to be closely allied to the Standard Oil interests.

Our contemporary, "The Electrical Engineer," comments upon the proposed transfer as follows:

> The United Gas Improvement Co. offers to take over this miserably mismanaged plant on a lease, it is understood, spending $10,000,000 to bring it up to date, paying the city $1,000,000 in cash, and turning in a rental that in thirty years will amount to not less than $36,725,000. It is impossible not to believe that the offer will be accepted, and it is a mournful commentary upon the municipal plant craze that at a time when private gas works in other large cities are all exhibiting an appreciated value, this Philadelphia plant is a wreck, and will owe its rescue to private enterprise and good management. Yet, we do not regard the Philadelphia instance as exceptional. There may be and probably are several municipal plants well run, but it is as sure as the rising of the sun that the great majority of them are carried on at actual loss.

We regret that our contemporary's violent prejudice against municipal ownership in general should cause it to so misstate the facts and mislead its readers.

It appears to us to be rather stretching things to call the Philadelphia gas plant a "wreck." In 1896 the receipts of the works exceeded the current expenses by $88,000, according to the city reports, and furnished free gas to the amount of 674,032,000 ft. for use in street lighting and the public buildings and offices of the city. Crediting this at $1 per thousand, which is probably as little as the city would be able to get its gas lighting supply for if the works were owned by a private company, we have a total of $763,022 per annum as the net earnings. This may be the "Electrical Engineer's" idea of a wreck, but we hardly think most persons would so consider it.

It is true that the Philadelphia gas works have been mismanaged. So have some other gas works owned by private companies in cities not a thousand miles from New York. But there is no small reason to believe that a considerable part of the mismanagement of the Philadelphia gas works is to be laid at the door of those who have long been desirous of getting hold of these works, and to that end have used their influence to prevent necessary extensions and improvements. The works have been allowed to deteriorate and run down and the money that should have been spent upon them has been spent for other city purposes.

But, notwithstanding all this, the fact remains that the Philadelphia gas user pays lower rates than the gas consumer in New York. If a comparison were made between the Philadelphia gas works, owned by the city, and the gas works in New York city, owned by private companies, we believe it would be found that for every dollar wasted in the Philadelphia works by bad or corrupt management, two have been wasted in New York in the laying of useless duplicate lines of mains on the same street by competing companies, and by waste and mismanagement by companies organized for stock jobbing purposes.

In the article from which the above quotation is made, Mayor Warwick, now at the head of the city government of Philadelphia, is quoted as recommending to the city council that the plant be leased to private parties, urging that $5,000,000 ought to be spent for its improvement in the next three years, and large sums in the future, which the city cannot obtain without increasing the tax rate. It is pertinent to ask why Mayor Warwick does not recommend that the surplus revenues of the city's gas plant, including a proper allowance from the city for gas used for public purposes, should be used for necessary improvements, and why they have not be so used in the past? Why should the gas consumers of Philadelphia be required to pay for the lighting of the streets, the asylums, and the city offices?

In our issue of Sept. 9, the title "M. Am. Soc. C. E." was by mistake placed after the name of Prof. Wm. P. Mason, at the head of his paper, entitled "Expert Testimony."

THE COMPUTATION OF STRAINS IN COAL AND GRAIN BINS.

The recent failure of a large coal bin at Paterson, N. J., resulting in the shutting down of the electric light station and the street railway system of the city, has called general attention to the dangers which may exist in these huge overhead coal storage bins which are a feature of nearly every steam power station of modern design. The question whether the coal bin in any station can safely carry the coal which may be heaped into it, is one which few Superintendents of electric light and electric railway plants would be able to answer; and we fear not every engineer responsible for the design of these structures would be prepared to stand a severe cross-examination in case the failure of some structure of his design should result in a suit for damages.

The fact is that there is comparatively little matter in engineering literature upon the strains in such structures as grain elevators and coal bins which appeals to the practical engineer as thoroughly safe and reliable. There is much on the kindred subject of retaining walls; but so much of it is inapplicable to bin strains, that it is difficult for the average engineer to find the information he desires. We have, therefore, thought that a general discussion of the subject of bin pressures might be of interest to our readers. Let us preface it, however, by remarking that we lay no claim to infallibility and shall be glad to have errors in the discussion pointed out to us. Further, at the risk of exhausting the patience of some of our readers, we shall make our discussion quite elementary, for the benefit of those who may either never have paid attention to this subject, or may have grown rusty in their knowledge of it.

Suppose we take for our example a coal bin like the one at Paterson, cross-sections of which are given elsewhere in this issue, and which has the general form shown in Fig. 1. We select this because it is a typical form of coal bin; and as it has both straight and inclined sides, it serves well to illustrate general practice in the design of bin structures of all classes.

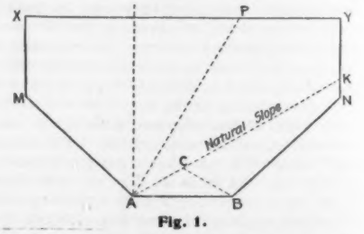

Fig. 1.

If we slowly pour out upon the center of the floor of any such bin a mass of grain, coal, sand, or any similar substance, it will accumulate in a mound with sloping sides, and the height of this mound and the width of its base will increase until it covers the floor of the bin and takes a form similar to A C B (Fig. 1). Evidently, if only this

FIG. 19. HANDLING ROCK WITH WAGONS AND INCLINES.
DONNELLY & CO. BUFFALO, N. Y., CONTRACTORS.

FIG. 21. LIDGERWOOD CABLE
LOADED WI
CHARLES F. PARKER & CO., NEW

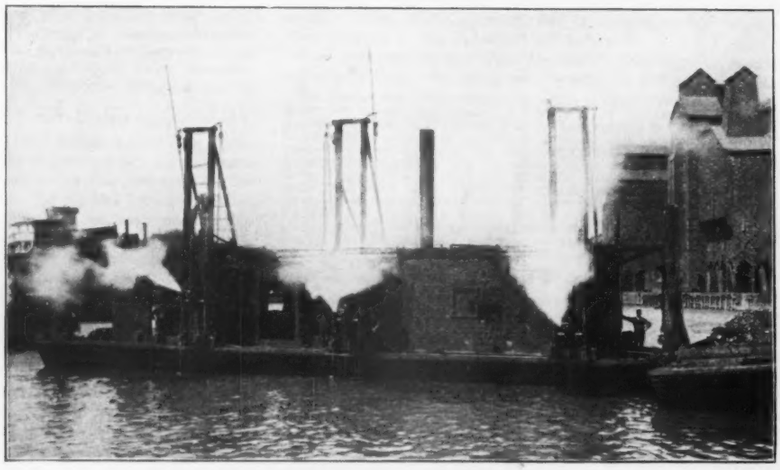

FIG. 22. DRILLING ROCK UNDER WATER
WITH DRILL BOAT "RAND."
BUFFALO DREDGING CO., BUFFALO, N. Y., CONTRACTORS.

FIG. 15. SINGLE DERRICK PLA
GALLO & McNIECE, NEW YO

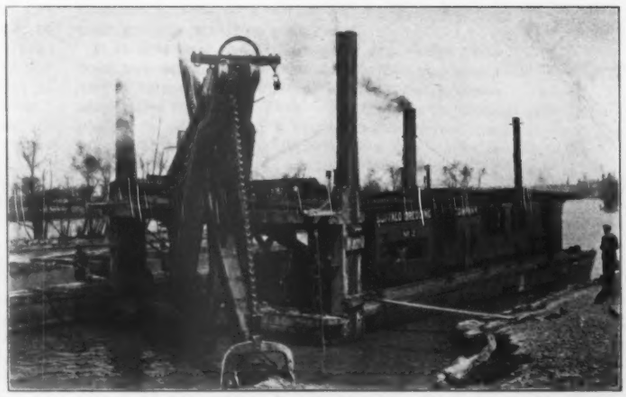

FIG. 23. DIPPER DREDGE EXCAVATING EARTH UNDER WATER.
BUFFALO DREDGING CO., BUFFALO, N. Y., CONTRACTORS.

THE NEW YO
CANALS IMPRO

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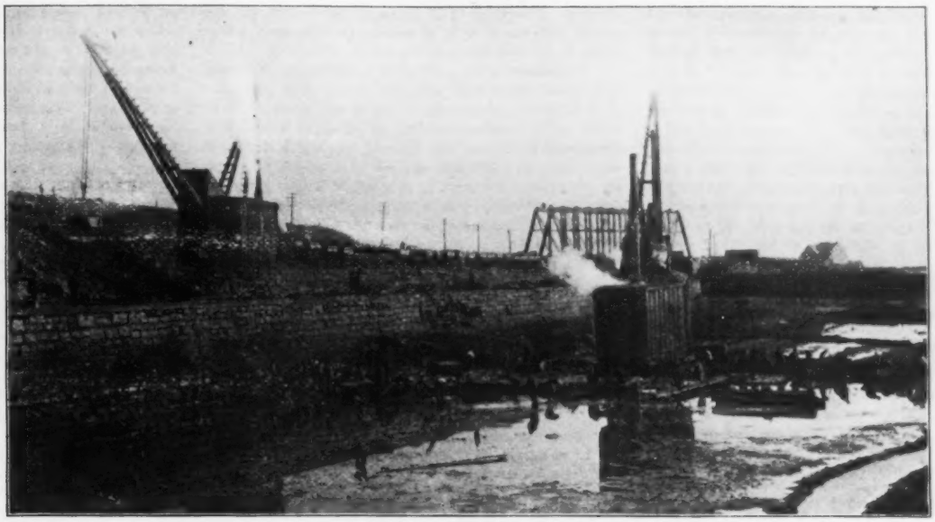
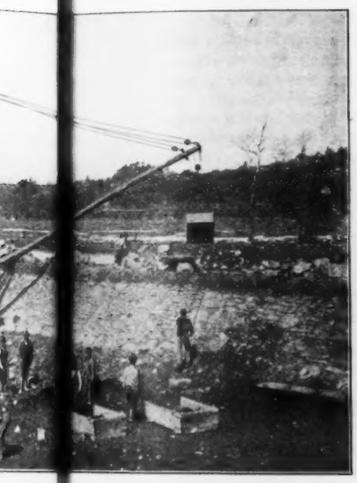


FIG. 14. TWIN DERRICK PLANT FOR HANDLING EARTH.
FURNACEVILLE IRON CO., SUBCONTRACTORS UNDER DONNELLY & CO., BUFFALO, N. Y.



RICK PLA T FOR HANDLING EARTH.
NEW YO K, N. Y., CONTRACTORS.

FIG. 20. REVOLVING DERRICK LOADING ROCK
ON BERM INTO CARS.
FURNACEVILLE IRON CO., SUBCONTRACTORS UNDER DONNELLY & CO., BUFFALO, N. Y.

EW YORK STATE
S IMPROVEMENT.

Y USED IN EARTH AND
K EXCAVATION.)

Adams, State Engineer.
rts, Deputy State Engineer.

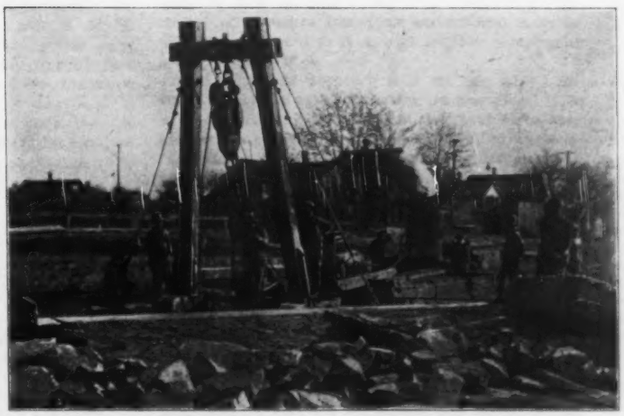


FIG. 25. PILE PULLING SCOW AT WORK.
BUFFALO DREDGING CO., BUFFALO, N. Y., CONTRACTORS.

amount of grain or coal is placed in the bin, no pressure will be exerted on the sides; and it is, perhaps, equally easy to see that when an additional amount is placed in the bin, it will be this additional amount only which will exert pressure on the sides. No matter what load may be placed on the mound A C B, by pouring additional material into the bin, if the mound A C B does not touch the sides, it can exert no pressure against them.

We thus arrive at the conclusion that, in any bin of the general form shown in Fig. 1, we can be sure that of the total material in the bin, that part within the triangle A C B will exert no pressure upon the sides. As most of our readers will recognize, the angle C A B is the familiar angle of repose, or the slope that the material naturally takes when free to slide down upon itself as it is heaped up. The size of this angle varies, of course, with the nature of the material. In a mass of broken stone, for example, the pieces move upon each other with so much friction that it stands at a very steep slope. At the other extreme, small shot move upon each other with facility, and the slope A C will be flat. The condition of a material largely influences its angle of repose. Dry, clean sand, for example, assumes a very flat slope. If slightly moistened, the grains become somewhat adherent, and it stands at a much steeper slope. If the moisture is increased, so that the water between the grains is sufficient to act as a lubricant, their facility of movement is greatly increased, and the sand may take a flatter slope than when dry.

Let us consider now the strains exerted on the sides of the bin by the mass above the mass of triangular cross-section A C B. First let us notice that we may obtain the pressure upon one side of the bin without regard to that on the other. The strain upon the side A M X is the same, no matter whether the opposite side B N Y is at the position shown in Fig. 1, or a mile farther away.

What, then, produces pressure upon the side A M X? Evidently it is the mass of coal whose end section is the figure A K Y X M. Suppose this mass is free to slide down the slope A K without friction, the horizontal pressure against the side A M X will then depend upon the steepness of the slope A K. If this slope is very flat, most of the weight will be transmitted to the surface A K C, and on the other hand, a larger mass will be effectual in producing pressure. If the slope A K is very steep, very little weight will be carried by the slope, and on the other hand, the mass whose section is the figure A M X K will be much smaller in volume. Evidently, then, there must be some angle for the line A K which will give a prism that will exert the maximum pressure upon the side A M X.

By a mathematical calculation which we will not take space to reproduce here, this angle of maximum pressure can be shown to be the angle between a horizontal and a line A P which bisects the angle between a vertical line and the line A K, formed by the natural slope of the material. To compute the pressure against the side A M X, therefore, we determine the weight of the mass whose end section is A M X P, and consider this weight as sliding without friction down the slope A P.

Let us first obtain the pressure upon the inclined side A M. Referring to Fig. 2, let the line

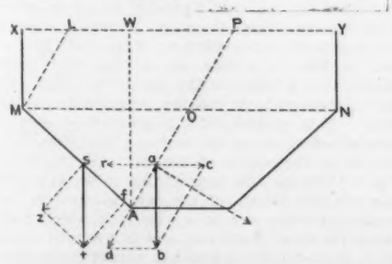


Fig. 2.

A P be the slope of maximum pressure, and suppose the bin be first filled to the level M N. Then the triangular mass M O A will exert a pressure upon M A. Now suppose the bin to be filled to the level X Y. Then the triangular mass M O A must carry the weight of the mass M X P O directly over it.

We have then the mass M X P A as that whose weight produces pressure upon the side M A. How shall we proceed to determine this pressure?

In the first place, suppose this mass were free to slide down the slope of maximum pressure P A, which we suppose to be frictionless. The force urging it down the plane is the weight of the mass, and this force, a b, we can resolve into two components, one a horizontal pressure a c against the plane P A, the other a force, a d, parallel with this plane. But this horizontal pressure a c against the plane P A is opposed by an equal and opposite reaction a r of the plane, P A. That is to say, in sliding down the plane P A the mass M X P A is pushed horizontally to the left by a force which depends on the weight and on the inclination of the slope A P.

In the second place, we have the weight of this mass, M X P A, resting against the side M A. At which points on the lines M A and O A can we consider these forces as concentrated ?

If this mass were a liquid, it can be shown by the laws of hydrostatics that the distance of the center of pressure on M A below the plane X Y would be:

$$\frac{2}{3}\,\frac{(W\,A)^3 - (X\,M)^3}{(W\,A)^2 - (X\,M)^2}$$

In which W A is the depth of the lowest point of the side M A below the surface of the liquid, and X M is the depth of the highest point of this side.

If the mass X M P A were a solid, we would find its center of gravity and consider its total weight as a vertical force acting upon the wedge O A M to press against the side M A.

Actually, however, the mass is much more like a liquid than a solid, and it seems advisable, therefore, to assume the center of pressure at the point

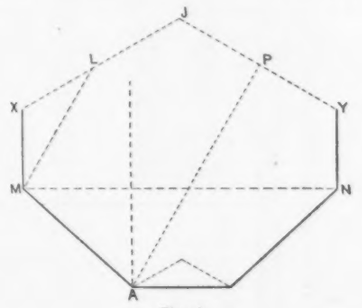


Fig. 3.

corresponding to liquid pressure rather than at the point where a line through the center of gravity of a solid would fall.

To compute the normal pressure upon the plane M A, therefore, we would resolve the weight of the body M X P A, and equal to s t, acting at the center of pressure found as above, into a component s z normal to M A, and another component s f parallel to M A.

The horizontal pressure a p we can also consider with little error as acting on the plane M A at the point s. We have then the total force acting on the member M A and its point of application, and it is then a simple matter to compute the proportion of this force which is transmitted to the point M, and thence to such members as may be provided to resist the pressure against the sides of the bin.

It still remains to obtain the pressure against the vertical side X M. This, however, is a comparatively simple matter. We have only to compute the horizontal thrust due to the wedge whose end is X M L in sliding down the plane of maximum thrust M L. This thrust can be considered as concentrated at a point on X M, distant one-third its length from M, according to the laws of hydrostatics, and the amount of the thrust acting at M and at X can then be computed by the simple principle of the lever.

In the preceding discussion we have assumed that the bin was level full. If it be heaped, as shown by the lines X J Y, Fig. 3, the process is the same. We have, as before, the slopes of maximum pressure A P and M L, and the methods followed for the analysis, and for the composition and resolution of forces are exactly the same. The weights acting are, of course, considerably greater, and it will be seen that nearly all the material in the heaped portion above the horizontal line X Y is effective in producing thrust upon the sides.

We believe that by following out and applying the above analysis, the computation of strains in large coal bins will be found a comparatively simple matter; and although our explanation has been necessarily extended on account of its elementary nature, the process we have outlined will, we believe, be found to be little, if any, more tedious than other methods which use approximations farther from the truth.

LETTERS TO THE EDITOR.

A 60-Ton Steam Shovel for Railway Work.

Sir: We note with interest the article on our steam shovel in your issue of Sept. 16, but you have made an error in stating the size of the main engines of this shovel, as being 10 × 11 ins., whereas it should be 10 × 14 ins. This is quite a difference, and we would like you to correct it. Yours very truly, The Bucyrus Company,

A. W. Robinson, Engineer.

South Milwaukee, Wis., Sept. 18, 1897.

Fast Trestle Construction Over Water.

Sir: In your issue of Aug. 12, under the heading of "Quick Renewal of a Burned Railway Bridge," Mr. C. F. Neeb claims the time in which the 450 lin. ft. of burned bridge over the Scioto River (C. M. & V. Ry.) was replaced, comes very close to if it does not break the record for fast work. His impression on this subject must be erroneous, as replacing 450 lin. ft. of bridge in 50 hours is approximately only 7 6-10 lin. ft. per hour.

While on the N. O. & N. E. Ry., in October, 1885, the trestle over Lake Pontchartrain caught fire at 10 p. m. Saturday, burning out 3,975 lin. ft. of trestle. At 5 p. m. on the following Friday the 3,975 lin. ft. had been replaced and trains were crossing. Elapsed time from the discovery of the fire until the trestle was replaced, 139 hours; length of trestle replaced, 3,975 lin. ft.; average feet of trestle constructed per hour, 28 8-10 lin. ft.; or nearly four times that constructed per hour on the bridge quoted by Mr. Neeb.

The lake trestle in question averaged 12 ft. above ordinary water; the average depth of water under the burned portion of the bridge was 12 ft.; water was rough and choppy, and it was 5 miles from the burned portion to the shore, from which material was delivered. The average number of hours worked out of the 24 was 15; average number of carpenters and laborers in service, 135.

Taking into consideration that most railways carry a stock of material sufficient to construct such trestle as Mr. Neeb names, and that but very few, if any, carry a stock of such material as would be required to reconstruct the 3,975 ft. burned on Lake Pontchrtrain (more than two-thirds of the material used in the latter work had to be cut in the woods and transported to the point, after being handled by the mill people), and considering that nearly five-sixths of the work Mr. Neeb claims as fast was on dry land, while the other was all over water, your readers will easily recognize the difficulties attending the one and the ease of accomplishing the other.

Yours truly, Douglas Hoagland.

Bridge and Building Department, Cincinnati, New Orleans & Texas Pacific Ry.

Somerset, Ky., Sept. 13, 1897.

Notes on a Railway Journey to Russia.

Sir: Some of your readers may perhaps be interested in the following random notes of a journey from England to Russia, recently made by the writer:

Starting from London, the first part of the route was over the Great Eastern Ry. to Parkeston, where steamer was taken across to the Hook of Holland, and after the baggage had been examined we proceeded to Amsterdam and thence directly on to Berlin. Through Holland the country was flat and not interesting, except in regard to the quaintness of the buildings and windmills and the customs of the people; all had an ancient appearance and seemed to be behind the times. Our train, however, was a good one, with corridor cars, and we went at a good speed, arriving at Berlin on Monday. I had not time to go beyond the station, but at once secured my ticket for Warsaw, which we reached on Tuesday night. All through Germany the military element predominated along the railways, the railways being owned and operated by the government. At Warsaw my trouble began, as I could not make myself understood, in spite of pointing to maps, etc., but the man at the money exchange office spoke enough English to give me instructions to get on to Alex-

androvno, a large junction where I had again to secure tickets, but with the same trouble from lack of knowledge of the language until an official came up who spoke a little English and also wanted a tip. However, I got my ticket for Ekaterinburg via Moscow and another tip got me a seat in the car. There were a great many military officers at the station, and in spite of the very hot weather all had their long overcoats on, and it was amusing to see some of the pompous fellows scowl at an inferior if he did not properly salute them in public, and then themselves hasten to salute some superior officer. Moscow was reached at 9 a. m. on Wednesday, and at the station a friend secured me a drosky. This is a cab on four small wheels. The passenger sits in the back seat and the driver on a little dickey in front. The driver wears an old 18th century beaver hat with bell top, low crown and turn-up brim; then he has a dark blue coat and blanket all in one, reaching from his neck to his ankles and tied around the waist by a crimson band. He also has sheepskin gloves and top boots. The reins are made of a woven band, with the ends tied in a knot to which a whip thong is attached. There is very little leather about the harness, more string than anything else, and over the horse's head is a yoke from shaft to shaft and even that was tied on. The horse was a fiery little Russian, long-tailed and maned, and only seemed at home on the gallop. The streets are covered with big cobble stones and have gutters across them over which you go up and down in a very rough sort of manner. How the harness or the whole concern keeps together I have yet to learn, for while trying to guess, there was a vicious jump over a gutter and out went my bag over the driver's dickey. He pulled up so short that I nearly went on his back, and in getting out to pick up the bag he was nearly run over by another drosky, while our horse would have bolted if I had not snatched the reins. However, we went on again just as before, the driver paying no attention to the pedestrians except at crossings where a military policeman was on duty. On reaching the other railway station, there was more trouble from my lack of knowledge of the language, or of either French or German, and after wasting an hour I was directed to a third large station, the officials seeming to think I had no business there unless I could make myself understood. At this third station the manag the buffet spoke a little English and found out for me the proper time, train and platform, after which I took a turn in the city. The buildings and churches are all painted white, roofed with sheet iron painted green, and the tops of the domes are gilded. The streets are broad, but paving and sidewalks are execrable, and there seem to be no sanitary arrangements at all. At 3.30 p. m. we left Moscow and I spent most of my time on the gangway at the end of the car and took such mental notes as I could, as writing was not possible owing to the jolting of the train and the clouds of grey dust. There were six persons in the compartment. The backs of the seats were lifted up at night to form the top berths. At noon on Thursday we crossed the River Volga by a bridge of 14 spans. The river is broad and the small steamers which run upon it all burn oil. At 3 p. m. we reached Vimla, a large station and junction. At all the stations there were numerous priests, and in every buffet was a figure of the Christ or the Virgin and child, with a lamp burning before. I tried some of the messes in the buffet but could not get on. The tea (served in half-pint glasses) and some white bread were all that I could manage. Friday we had a continuous run over flat country and as it was a moonlight night I remained on the gangway or platform of the car so as to see the scenery, and be more comfortable than in the compartment with five snoring Russians and the temperature very warm. On Saturday we crossed the River Ural by a bridge of 65 spans and then began the scenery of the Ural Mountains, which is almost equal to that of the Rhine, except for the old castles. After hundreds of miles of level plains it was an agreeable change to be traveling through forests and climbing mountains. Our train of 25 cars was hauled slowly up by two large engines, one burning wood and the other oil. At the summit was a large engine shed and small village. At 6 a. m. on Sunday we arrived at Cheliabinsk, which has a large station built of wood, like all the other stations. It has also large sheds for the emigrants, who, since the districts of Siberia have been opened up by railway, are going by thousands from the Caucasus and the south. At most stations we passed trains of them, but here there were a thousand peasants lying about in rags and dirt. They are driven into the cars like sheep in a pen, the old people being stowed in the upper part and the rest packed in any how. When full the sliding doors are shut and two little windows on each side are all their ventilation. These are fourth-class cars and resemble four-wheel boxcars. We left here at 10 a. m., but owing to the heavy emigrant traffic did not reach Ekaterinburg until midnight, though we were due at 5 p. m. The houses are built of wood and have generally one floor. If there is any other it is for the servants and is below the main floor. Where I am staying, the heating and cooking apparatus is all down below and there is not a single fireplace in the building and no upper floor.

J. H. N.

Ekaterinburg, Russia, Aug. 12, 1897.

THE FALL OF AN ELEVATOR IN THE BUILDING OF THE AMERICAN TRACT SOCIETY.

In last week's issue we gave an account of the fall of a passenger elevator in the building of the American Tract Society, in New York city, by which two men were killed. We give herewith some illustrations showing the construction of the elevator machinery and safety appliances. The hydraulic machinery is of a somewhat novel type, first introduced by the Crane Elevator Co., of Chicago in 1894. Figs. 1 and 2 are taken from the company's catalogue describing the system, issued in October, 1895. The lifting apparatus comprises a long cylindrical cast iron plunger which passes through a stuffing box in the top of a vertical pipe or casing erected in the elevator shaft. The plunger is raised by admitting water from an accumulator at a pressure of 250 lbs. per square inch into the casing through a three-way hydraulic valve near the bottom, and is lowered by allowing the water to escape through the same valve into a large closed tank in which a pressure of about 60 lbs. per sq. in. is maintained by means of an air pump, the upper portion of the tank being filled with compressed air. If the pressure in the air tank is reduced from any cause, and the engineer in charge notices it, he may start the pump and restore the pressure. Journaled in a frame attached to the top of the plunger is a single sheave, grooved for the wire ropes eight in number in the present case), which support the elevator car. These ropes, fastened at one end near the top of the elevator shaft, pass down and around the sheave on the top of the plunger, thence upwards and over a sheave mounted on beams which cross the top of the shaft, thence downwards to the elevator car. It will be seen that by this arrangement the car is made to travel twice as far and twice as fast as the plunger; in other words, the machine is geared 1 and 2. The casing and the plunger are therefore each equal in length to about one half of the height of the elevator shaft, or, in the building in which the accident took place, each is about 120 feet long. The plunger acts as a counter-weight to the car and its load, and since its motion is only half that of the car, it must weigh at least twice as much as the car with the heaviest load it is designed to carry, plus the weight required to drive the water out of the casing against the pressure maintained in the water-tank, and the weight required to overcome the friction of the machinery.

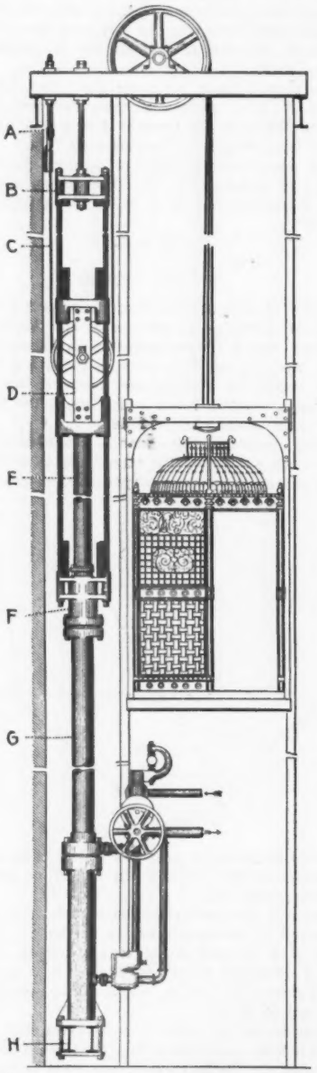


Fig. 1.—Vertical Plunger Hydraulic Passenger Elevator. The Crane Elevator Co., Chicago, Ill.

A. Dead End (Fastening of Cable).
B. Upper Buffer.
C. Guide Bars for Traveling Frame.
D. Traveling Frame.
E. Plunger.
F. Stuffing Box.
G. Casing.
H. Foundation Plates.

The resistance offered by the water to the descent of the plunger, the discharge valve being open, is a variable one. When the plunger is at its highest position the pressure of the water upon it is the least, since the column of 120 ft. of water in the casing balances 52 lbs. out of the 60 lbs. pressure per sq. in. in the discharge tank, leaving only 8 lbs. per sq. in. to press upward on the bottom of the plunger. When the bottom of the plunger has reached the level of the water in the discharge tank, the pressure upon it is equal to the air pressure on top of the water in the discharge tank, say 60 lbs. per sq. in. This increase of resistance as the plunger descends counterbalances the varying upward pull upon the plunger due to the change of position of the ropes as the car ascends. The resistance to the descent of the plunger is, of course, increased by the frictional resistance of the water pressure through the pipes and valve.

To raise the plunger and thereby lower the car, the hydraulic pressure in the casing must be sufficient to overcome the preponderance of the weight of the plunger over double the weight of the car, since the pull exerted upon the plunger by the weight of the car is doubled by means of the ropes passing around the sheave on the top of the plunger. In the elevator in the American Tract Society's building the plunger is 7 5-16 ins. diameter and about 120 ft. in length. With the frame and sheave which it carried it weighs about 16,000 lbs. The empty car weighs about 3,000 lbs., and counterbalances about 6,000 lbs. of the weight of the plunger, leaving the difference of about 10,000 lbs. to be exerted by the hydraulic pressure in order to raise the plunger and lower the empty car.

Fig. 2, also from the Crane Elevator Co.'s catalogue, shows the handling device, by means of which the valve is operated. It consists of an endless cable carried with the car and running over the sheaves B and D. On the shaft that supports the wheel D is a small pinion geared into a segment connected with the tilting arms used in the ordinary lever handling device. The operator grasping the endless cable at C is enabled to control the valve E and thereby the speed of the car with great nicety.

The safety appliance upon the car, which was furnished by the Otis Elevator Co., is shown on Figs. 3 and 4, drawn from blue prints, for which we are indebted to the courtesy of the Otis Elevator Co. In Fig. 3 is seen an endless cable which passes over a wheel at the top of the shaft. This wheel, through bevel gearing, drives a fly ball governor. This endless cable is grasped by a spring grip attached to the elevator car, and it therefore moves at the speed of the car. To the fixture which joins the two ends of this cable, at a point opposite the bottom of the car, is attached by a swivel joint the end of a wire rope which passes under the floor of the car, and is wrapped several times around a drum, which is part of the mechanism that throws the safety grips, hereafter to be described. Whenever the speed of the car, either up or down, becomes from any cause greater than that for which the governor is adjusted, the governor balls fly out, and through a system of levers

cause a pair of eccentrics or cams, which are geared together and are placed just below the governor-wheel, to grip tightly the moving endless cable, bringing it to rest so that the spring grip slips along it as the car continues to move. The rope under the car, which is wrapped on the drum, having its outer end attached to the endless cable, and the cable having been brought to rest by the operation of the cams, the continuing motion of the car in either direction now makes a pull on the rope, which causes the drum to rotate so as to unwind the rope and allow its outer end, which is attached to the endless cable, to move relatively to the car, either upwards, if the car is moving downwards, or vice versa. The two small pulleys seen under the corner of the car allow the rope to run in either one of the two directions. By this means the moving car itself furnishes the motive power which rotates the drum underneath the car, and thus operates the safety grip mechanism shown in Fig. 4. The safety clutches may be

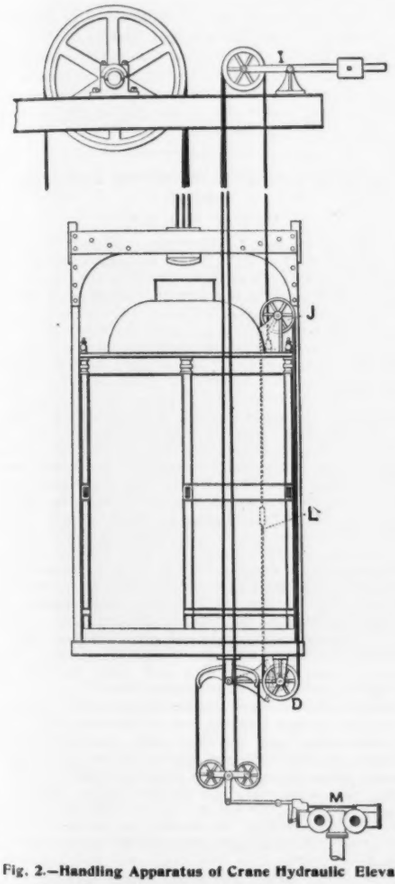


Fig. 2.—Handling Apparatus of Crane Hydraulic Elevator.

I. Lever Supporting Controlling Ropes.
J and K. Sheaves for Endless Cable.
L. Controlling Device attached to Endless Cable.
M. Operating Valves.

caused to operate by a safety rope in the car as well as automatically,

In Fig. 4 the drum is seen with the rope wrapped around it. Two bronze nuts, placed axially at the ends of the drum, are rotated by the nut at one end engaging a right-handed and that at the other a left-handed screw. These screws operate by means of a toggle joint motion, two powerful jaw grips, the jaws of which grasp with gradually increasing pressure, as the drum continues rotating the T iron guides on the sides of the elevator shaft, and thus bring the car to rest gradually and without serious shock, the energy of the moving car being absorbed by friction of the jaws upon the guides. After the safety grips have stopped the moving car they may be released by rotating the drum, by means of a capstan on the drum operated by a bar, which is inserted in the holes in the capstan through a trap door in the floor of the car. The rope is thereby rewound on the drum, and if the bar is removed from the capstan the safety mechanism is returned to its original position and is ready to operate as usual whenever the car attains a greater speed than that for which the governor is adjusted. But if, by neglect of the operator, the bar is left in the capstan, it of course locks the safety grips open, so that they cannot be operated either by the governor or by the safety rope.

One of the possible contributing causes of the fall of the elevator on Sept. 10 is that the night engineer, after having released the safety grips, may have left the capstan bar in place, thus locking the grips open. If, after doing this, the car on continuing its upward trip reached such a speed as to cause the governor to throw in the eccentrics which grasp the endless cable and bring it to rest, the car continuing its motion would bring a pull on the rope under the car, tending to rotate the drum, but failing to do it on account of its being locked by the capstan bar. In this case something would have to break; most likely the attachment of the rope to the endless cable, which was not designed strong enough to break the capstan bar or the rope itself, in case some one wrongfully left the bar in the capstan. This attachment was found in a broken condition in the debris after the accident.

There may, however, have been an entirely different cause for the breaking of this attachment and the consequent rendering inoperative of the safety device. In the rotating of the drum of the safety device by the pull on the rope coiled upon it, the rope is subjected to a considerable strain, which may be increased when the grips have firmly taken hold while the car has not yet been brought quite to rest, to such a point as to break the attachment of this rope to the rope which drives the governor. This breaking of the attachment is possible to take place whenever the safety grips are thrown in suddenly, but no danger usually is occasioned thereby, because the break is repaired and the safety device made operative again before the elevator is again used.

Some evidence has been produced before the coroner's jury to the effect that the attachment was broken in this manner. The janitor of the building said that when the car was stalled between the first and second floors he noticed the rope belonging to the safety device hanging down in a loop for two or three feet. This is the way it might appear if the attachment were broken. If the attachment were not broken the rope would be drawn up tight.

Leaving for the present the consideration of the probable causes of the accident, we may discuss the mechanism of the elevator system to learn if possible whether it has any inherent elements of danger which may be eliminated in future constructions.

The safety grip appliances seem to us admirably adapted to their purpose. They operated just prior to the accident exactly as they should have done, and we see no room for doubt that they would have operated again and checked the upward flight of the car if they had not been either locked open by the engineer in the manner mentioned above or rendered inoperative through the breakage of the ropes or some other of the parts which cause them to close. If the latter was the case, the accident could be ascribed to the failure of the engineer to make sure that all this apparatus was in proper order before releasing the grips.

We doubt not that this accident will serve as a warning in this matter to all those responsible for elevator machinery. The closing of a safety grip is a not infrequent occurrence in high speed elevator service, and it can be readily understood that even with the best and most careful design, something is likely to be broken or deranged when a weight of four or five tons or more is brought to a sudden stop from a speed of 600 to 1,000 ft. per minute. All those in charge of elevators should be warned on no account to release safety clutches and put their cars again in service without making sure that all their parts are in good condition and ready to operate again.

As for the hydraulic lifting apparatus, it has many excellent points, such as saving of room, saving in the number of sheaves, journals and bearings and of the friction of their operation, economy of power and general simplicity of design. The system, however, appears to have some elements of danger to overcome which requires a high degree of skill both in design and in construction. There is a slender vertical cylinder of the great height of 120 ft., out of the top of which extends for another 120 ft., through a stuffing box 1 ft. in depth, a plunger 7 5-16 in. in diameter, weighing about 16,000 lbs. This plunger moves up and down in the cylinder at a speed which may reach 600 ft. per minute before the governor acts to lock the car. The car, if ascending, must be brought to rest

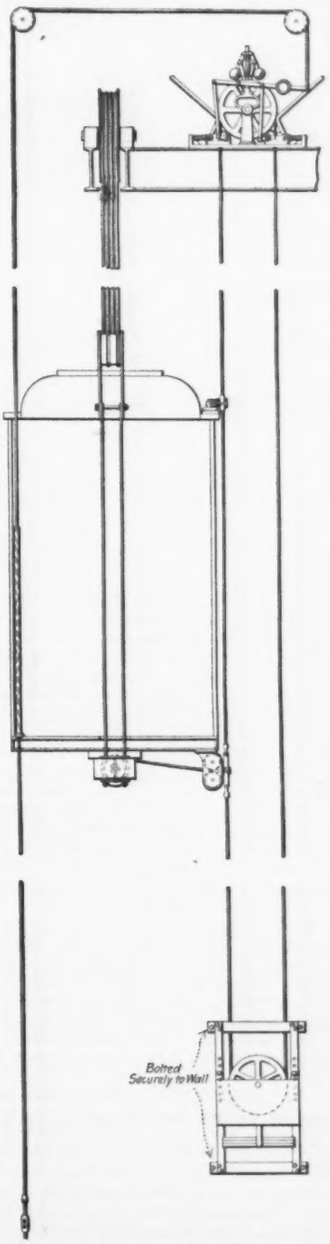


Fig. 3.—Governor Ropes and Connections to Safety Grips. The Otis Elevator Co.

gradually by the friction of the safety grips on the guides or else the momentum of the descending plunger would bring a dangerous shock upon the ropes. If, while the plunger is descending, the discharge valve is suddenly closed, the momentum of the plunger would cause a water hammer were it not for the relief valves, which open to discharge the water into the pressure tank when the pressure in the cylinder exceeds 250 lbs. per sq. in.

These elements of danger being controlled by the provisions of a large factor of safety in the ropes, ample area of relief valves and gradual operation of the safety grips, the effect of a possible

leak from any part of the hydraulic cylinder remains to be considered. If the car is free to move, not being locked by the safety grip, a leak would simply allow the plunger to descend and the car to be thereby raised at a speed proportional to the area of the leak. If the escape of water from the leak or from the discharge valve, or from both, were sufficiently great to cause the car to ascend at a speed greater than that for which the governor is set, the latter would operate, bringing the car to rest. The car being now locked and the leak continuing, what would happen next would depend upon how the three-way hydraulic valve

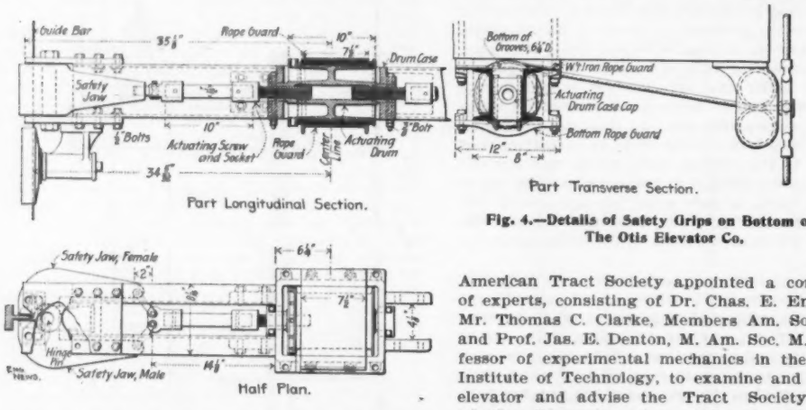


Fig. 4.—Details of Safety Grips on Bottom of Car. The Otis Elevator Co.

were set by the operator. If it were opened so as to admit from the accumulator the working pressure of 250 lbs. per sq. in., nothing would happen, if the leak were small, for that pressure is insufficient to raise the plunger when it is not counterbalanced by the car. If it were open to the discharge tank, which is under air pressure of 60 lbs. per sq. in., and if there were a free opening to admit water from the discharge tank to the cylinder, this pressure would keep the cylinder full of water (there being an air escape valve at the top of the cylinder), provided this opening from the discharge tank were sufficient to admit more water than the leak allowed to escape. If, however, the leak of water were greater than the admission, or if by the escape of water from the system, due to the leak, the air pressure in the tank should be reduced from 60 lbs. to below 52 lbs. (the pressure required to sustain a column of water 120 ft. in height, the water in the cylinder would fall, leaving a vacuum above it. In case there were a slight leak of air through the stuffing box, there might be air instead of a vacuum above the water level in the upper end of the cylinder.

There being either air or a vacuum in the upper part of the cylinder, suppose the car were suddenly released by the operator unlocking the safety grips. The plunger, weighing 16,000 lbs., being unsupported by water pressure, and counter-balanced only by double the weight of the car, or say, by 6,000 lbs., would immediately fall with great velocity, and if the safety clutches were inoperative, the car would rise with double the speed of the falling plunger. The plunger would be arrested by striking the water remaining in the cylinder, but the car would continue moving upward until brought to rest by its own gravity or by striking against the top of the shaft, in either case slacking the ropes. The ropes, eight in number, would immediately twist and kink, as it is the nature of wire ropes to do when released from strain. The car having reached the end of its upward flight would then fall and bring a sudden shock upon the kinked ropes, which would in all probability be sufficient to break them and allow the car to fall to the bottom of the shaft.

Since the above was put in type the Coroner's investigation has begun and what follows has been prepared in the light of the evidence presented there.

It does not appear, as testified by Mr. George H. Reynolds, the Chief Engineer of the Crane Elevator Co., that the safety grips were thrown in by excessive speed of the elevator between the first and second floors, for the appearance of the guides shows that the grips began to take hold when the car had risen only 12 or 14 ins. from the ground floor; and when the car could not have attained a speed sufficient to cause the governor to throw in the safety grips. Mr. Reynolds is, therefore, of the opinion that the governor rope was pulled by some other force than that generated in the elevator itself.

Mr. Reynolds testified further that after this particular elevator had been put in the building, and the replacing of the other five high-pressure elevators by the plunger system, on which this elevator is constructed, was in contemplation, the American Tract Society appointed a commission of experts, consisting of Dr. Chas. E. Emery and Mr. Thomas C. Clarke, Members Am. Soc. C. E., and Prof. Jas. E. Denton, M. Am. Soc. M. E., professor of experimental mechanics in the Stevens Institute of Technology, to examine and test this elevator and advise the Tract Society as to whether the system was a safe one, and whether it should be adopted for all the elevators in the building. The commission, after very complete tests, reported strongly in favor of the system.

Mr. Reynolds was the engineer in charge of the construction of this elevator in Chicago, and of its erection in the building. Three days before the accident he had spent some hours examining all the elevators and their machinery, and found everything in perfect working order. Upon being asked by the Coroner what caused the elevator to ascend and strike the top of the shaft, and then fall to the ground, after releasing the safety grips, he replied to the effect that he could not account for it in any way; that he had studied every theory presented to account for the accident, and that not one of them was consistent with the known facts, and that he could frame no theory whatever to explain it.

Mr. Thos. C. Clarke, called by the Coroner as an expert, could also give no theory of the accident.

By the testimony of the Chief Engineer of the building and also by that of a workman employed by the Crane Elevator Co. in the building, it was shown that the pressure in the air tank was sometimes diminished by air leaks so that it was as low as 20 or 25 lbs. per sq. in., instead of 60 lbs., at which it is usually maintained.

As we go to press the Coroner's inquest is still being held and from all that has been learned no one cause, acting singly, will account for the accident. As is the case in most accidents, it was due to two or more causes, acting conjointly. From all the facts we have been able to obtain it appears to us by all odds the most probable sequence of the events at the time of the accident:

1. The car on its upward trip stopped 14 ft. from the ground, the safety grips beginning to operate almost immediately after starting. High speed of the car therefore could not have caused the throwing in of the grips, which must have been done by a pull on the safety rope which runs through the car, either by the passenger or possibly by its catching in the tube through which it runs in the car.

2. The operation of the safety device not only stopped the car, but broke the connection between the small rope which winds around the safety drum and the governor rope, so that the appliance would not again act as a safety device until this connection was repaired.

3. Twenty minutes after the stoppage the engineer released the grips.

4. During this time, or part of this time, the valve was open to the discharge tank.

5. During this time the pressure in the discharge tank was below the pressure required to maintain the water level at the top of the cylinder; or the water level in the discharge tank was lower than the discharge pipe leading into it, allowing air to pass through the pipe into the cylinder; in either case the discharge valve being open the water in the cylinder would be lowered and would leave either a vacuum or an air space below the bottom of the plunger.

6. The instant that the grips were released, the valve being open to the discharge tank, the plunger would fall, causing the car to run up the shaft with enormous velocity.

7. The safety device, being inoperative on account of the breaking of the small rope, would fail to act.

8. The car, mounting rapidly, might still possibly have been stopped had the operator moved the valve either to its middle position, stopping the outflow of water, or reversed it, provided that nearly all of the water had not already escaped from the cylinder.

9. The continuing motion of the car to the top of the shaft, after the plunger had come to rest, or nearly to rest, by striking the water remaining in the cylinder, would cause the ropes to kink, and when the car rebounded they would be broken by the combined strain due to the fall of the car and the kinking of the ropes.

FLETCHER'S PROCESS OF MAKING CAST-IRON PIPE.*

By S. S. Knight.†

In pipe making one of the greatest costs aside from the metal is the mold and the labor necessary to clean and render marketable the product. In the molding the chief cost is the making of the core and the maintaining of the barrel or core bar in working shape, especially for smaller pipe, such as 3, 4 and 6-in. In the cost of the core we will first consider the materials used in its manufacture. By far the most costly of these is the hay rope, or loose hay, that is put on as the combustible layer. This is then covered with clay, and this in turn with the so-called first coat usually made of clay and dirt taken from the previous cores. The bar or barrel with this cover is now dried. It is then taken out and upon it is turned the last finish coating of sand, sawdust, and previously used core dirt, after which it is given a coat of blacking. The finished core is now dried. This core when used burns and vents well, but leaves the core dirt stuck fast to the interior of the pipe. Since so much clay is used in making the core, the dirt has to be in a large measure cut out and much labor is required to clean a pipe so made. The necessity of the pipe being clean and free from adhering dirt will be apparent when it is noted that a coating of tar paint has yet to be applied. The two objections to this process will be noted, viz., the cost of the hay rope, which, on a 6-in. bar amounts to over 5 cts., and the labor required to clean pipe cast with such cores, due to the amount of clay used in their manufacture.

Among the recent improvements that have come forward in the pipe foundry business, none seems more deserving of consideration and use than that proposed by Dr. Fletcher, of Cincinnati, for making the cores just described. His invention was the result of patient labor extending over seven years, and although he met with pronounced success, he did not stop until he had given to the trade a method simple, economical, and which masters both of the difficulties pointed out in the use of the old method.

Early in the '90's Dr. Fletcher began experimenting with a view of doing away with the hay rope used. To accomplish this, mixtures of combustible substances, such as sawdust, leaves, etc., and earthy or mineral cements were made. The proportions were varied in every reasonable way with more or less success. But not until more recently did he conceive of his present method which at this time stands perfected in every detail. The method consists in mixing starch hydrated in water with sawdust, or any comminuted combustible material, and applying this to the bar or barrel directly by means of a wire gauze which passes under the bar and off from one roll on to another, the two rolls being geared to the bar. A 2% solution of starch is used and in practice this is mixed with an equal bulk of sawdust. About 25% of this starch solution is saved by being squeezed out by the gauze and collected, and is again ready for use.

After the bar is covered with the sawdust mixture it is placed in the oven and dried, when it is ready for the first and only coat of dirt. This dirt is the same in composition as the last coating in the old process, and since it contains no clay it can be easily washed out of the pipe.

The cost of applying this process on a 6-in. bar is less

*From a paper read before the Philadelphia Foundrymen's Association, published in the "Journal of the American Foundrymen's Association."

†Chemist of the Addyston Pipe & Steel Co., Cincinnati, O.

than 1 ct., or a saving of 4 cts. on the combustible coating on a single bar. In this new process only one-half of the dirt usually used is required and the saving in labor in the cleaning shed amounts to fully one-half. But a virtue of no small importance is the increased size of the bars used on all small pipe, since this coating may be put on any thickness desired. This increased size of the bars allows them to withstand rougher usage and materially prolong their life. Since no clay is used in the dirt core, the core is very porous and vents well. The gases forming near the molten iron escape back through the core, and thus the danger of blow holes in the iron is reduced to a minimum.

PROGRESS OF WORK ON THE MELAN ARCH BRIDGE AT TOPEKA, KAN.

We publish herewith a view showing the progress of work on the Melan concrete arch bridge being built for the city of Topeka, Kan., the details of which were illustrated and described in our issue of April 2, 1896. This bridge consists of five arch spans, one 125 ft., two 110 ft., and two 97½ ft. long, and it is expected to have it completed by Dec. 31, 1897. It replaced a bowstring truss bridge having six 150-ft. spans, and the illustration shows this old structure moved to one side and placed on temporary piers to carry the traffic during the construction of the new bridge. At the time the photograph was taken concreting was in progress on the first arch and the steel girders were just being placed on the second arch. The concrete is mixed in a revolving iron cylinder having a capacity of 1 cu. yd. at each charge, but generally a full charge is not used and only from 8 to 15 cu. yds. per hour are mixed. A cableway about 1,000 ft. long between towers is used for taking all material from the shore to its position on the bridge. For the piers below water Diamond cement from Middlebranch, Ky., is used, but for all portions above water Aalborg Portland cement from Copenhagen, Denmark, is substituted. Keepers & Thacher, of Detroit, Mich., are the designers and builders of the bridge, and Mr. H. V. Hinckley, of Topeka, Kan., is the engineer in charge. We are indebted to Mr. Hinckley for the photograph from which our illustration was prepared.

VIEW SHOWING PROGRESS OF WORK ON THE MELAN ARCH BRIDGE AT TOPEKA, KAN.
Keepers & Thacher, Detroit, Mich., Designers; H. V. Hinckley, Topeka, Kan., Engineer in Charge.

THE TEXAS WATERWAYS CONVENTION, as a general result of its late meeting, will petition Congress for an appropriation of $1,500,000 or $2,000,000 per year for the improvement of the harbors at Velasco, and at Aransas Pass, the inland water-course between Aransas Pass and Corpus Christi, and for the improvement of Buffalo Bayou.

EFFECT OF POSITION UPON THERMOMETERS AND RAIN GAGES.

The editor of the government "Weather Review," in the June issue, makes some interesting notes upon the position of thermometers and rain-gages, and the necessity of carefully noting relative position in any attempt to compare the records of distant stations.

With thermometers the most important sources of discrepancy are as follows: (A) A difference of a few feet in the height above the ground causes an apparent difference in extreme temperature at any two stations. (B) A difference in the manner of exposure; as one on the north side of a house and too close to the wall; another swingly freely in the shade of a tree; another still may be sheltered by double lattice work, where the wind is denied the freest access. (C) Unless thermometers are purchased of the best makers—and such are expensive—they are apt to differ between themselves by one or more degrees Fahrenheit. (D) The difference in immediate surroundings; due to being on hills or plains, in valleys or in the shadow of a mountain, or in a forest.

Rainfall records show even wider variations owing to the location of the gage. As the average of many years it is found that a rain gage placed about 100 ft. above the ground will catch only 65% of the rainfall caught by a gage on the ground. This is due to the more violent and active action of the wind at the mouth of the higher gage. For the same reason gages on or near the ground catch less or more as they are located in windy or sheltered spots. With a set of 14 gages Dr. Hellman, of Berlin, noted deviations of as much as 14% in the catch in a region where the average rainfall must have been practically identical for years. Close observation showed that this discrepancy was solely due to the degree of the strength of the wind at the mouth of the gages.

TEST OF A 200-HP. CAHALL BOILER.

We have received fromthe Cahall Sales Department, Pittsburg, Pa., a copy of a report made by Mr. Geo. H. Barrus, on a test of a 200-HP. Cahall boiler erected at the Narragansett Mills, Fall River, Mass. The test is remarkable in showing a very high economy, notwithstanding the fact that the temperature of the flue gases was rather high, viz., 619° F. Mr. Barrus states that the high temperature of the fluid gases and high economy are not inconsistent in this case, for the reason that the quantity of gas was unusually small, good combustion having been obtained with a very small excess of air. This is shown by the analysis of the flue gases, which showed, as an average, the remarkably high percentage of 15.1% of CO_2. The gas analysis is almost an ideal one, the free oxygen being only 4%, and the carbonic oxide only 0.7%. No explanation why the temperature of the chimney gases was so high as is given in the report. The boiler being driven at a rate of evaporation of only 3.2 lbs. of water per square foot of heating surface per hour, and the quantity of gas being small, as shown by the analysis, it would ordinarily be expected that the gases would travel at a slow rate along the boiler tubes, and have ample opportunity to give up their heat, and therefore, to pass into the chimney at a lower temperature than 619°. The following is an abstract of the reported results of the test:

Results of Evaporative Test of a 200-HP. Cahall Boiler at Narragansett Mills, Fall River, Mass., Aug. 5, 1897.

Kind of coal	Pocahontas.
Duration, hrs.	10
Weight of dry coal consumed, lbs.	6,507
Percentage of ashes and clinkers	6
Percentage of moisture in coal	3.3
Coal per sq. ft. of grate, per hour, lbs.	16.3
Water evap. pr hr. (corrected for superheating)	6,487.7
HP. developed, A. S. M. E. basis	223.4
Equiv. evap. per sq. ft. heatg. surf. per hr, lbs.	3.2
Average boiler pressure, lbs	110.7
" temperature of feed water, deg. F.	71.1
" " of flue gases, deg. F.	619.
" draft suction, ins.	0.14
Number of degrees of superheating, deg.	4.4
Total heat combustion per lb. dry coal, B.T.U.	15,529
Total heat combust'n pr lb. combustible, B.T.U.	15,457
Water evaporated per lb. dry coal, corrected for superheating, lbs.	9.97
Equivalent evaporation per lb. of dry coal from and at 212°, lbs.	11.841
Equivalent evaporation per lb. of combustible from and at 212°, lbs.	12.597
Efficiency, based on combustible, %	78.7
Average Gas Analysis by Volume.	
Carbonic acid (CO_2), %	15.1
Oxygen (O), %	4
Carbonic oxide (CO), %	0.7
Nitrogen by difference (N), %	80.2
Total	100.0
Data for Heat Balance.	
(Assumption composition of dry coal, carbon 84%, hydrogen 4%, ash 6%, oxygen 4%, sulphur and nitrogen 2%, = 100%.)	
Carbon in combustible, %	89.4
Hydrogen in combustible %	4.3
Moisture referred to combustible, %	3.5
Carbonic oxide referred to combustible	$\frac{0.7}{15.1+0.7} \times 89.4 = 4$
Hot gas, not including moisture, per lb. of carbon, lbs.	16.1
Hot gas, not including moisture, per lb. combustible, lbs.	$16.1 \times .894 =$ 14.4
Temp. of flue gases above air, deg.	$619 - 90 =$ 529.
Heat of combustion in 1 lb. of moisture in the gases, B. T. U.	1,283

Heat Balance.

Total heat of combustion per lb. of combustible by oxygen calorimeter ..... 15,457 B. T. U.

	B. T. U.	
Heat observed in useful evaporation, $12.597 \times 966 =$	12,168	78.7%
Loss by hot gas, $14.4 \times 529 \times .24 =$	1,825	11.8%
Loss by evaporation of moisture in coal and moisture formed by burning of hydrogen $(.043 \times 9 + .035) \times 1,283 =$	541	3.5%
Loss of unconsumed CO, $.04 \times 10,150 =$	406	2.6%
Radiation, carbon in smoke, hydro-carbons, and unaccounted for	517	3.4%
Total	15,457	100.0%

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Abutting Owners Entitled to Damage.

The construction and operation, on a public street, of an electric railroad extending between two or more cities and towns, for the transportation of merchandise, personal baggage, mail and express matter, as well as passengers, imposes an additional burden, for which the abutting owner is entitled to compensation, and is not merely the exercise of a public easement previously acquired by the construction of the street.—C. & N. W. Ry. Co. v. M. R. & K. Elec. Ry. Co. (Supr. Ct., Wis.), 70 N. W. Rep. 678.

Guaranty Not a Condition Precedent.

In a contract to construct a ditch, which was guaranteed to carry off all the water of a certain place for two years after its completion, the guaranty is in the nature of a warranty, and does not require the contractor to wait two years after completion of the ditch before becoming entitled to payment for same—Gilliam v. Brown (Supr. Ct., Cal.), 48 Pac. Rep. 486.

Implied Contract to Pay for Extra Lights.

An electric company furnished to a city a certain number of lights in excess of its contract. Afterwards it demanded payment for same, and on refusal, demanded that the city designate which should be removed to reduce to the contract number. The city refused to permit any removals. The court held that this made an implied

contract to pay for all of them from the time of refusal to permit removal.—Brush Elec. L. & P. Co. v. Montgomery City (Supr. Ct., Ala.), 21 Southern Rep. 960.

City Liable to Contractor.

A city which has agreed with a contractor for public work to levy and collect an assessment without delay, and which through a mistake in the law, fails to collect the assessment made and has to resort to reassessment, is liable to the contractor for damages caused by the delay.—Denny v. Spokane (U. S. Cir. Ct. App.), 79 Federal Rep. 719.

Obligation of City Contracts.

An ordinance granting a street railway company a franchise for a fixed period, during which the city is not to grant interfering privileges to any other company, constitutes a contract between the city and the company, and the city will be enjoined from granting any interfering privileges.—City Ry. Co. v. Cit. St. Ry. Co. (U. S. Supr. Ct.), 17 S. C. Rep. 653

BOOK REVIEWS.

THE UNIVERSAL DIRECTORY OF RAILWAY OFFICIALS, 1897.—Compiled from official sources by S. Richardson Blundstone, Editor of the "Railway Engineer." London: The Directory Publishing Company, Limited, 8 Catharine St., Strand, London. Cloth; 8½ × 5½ ins.; pp. 421. Ten shillings.

This is the third annual edition of a directory of the chief railway officers for the railways of the United Kingdom, Europe, Asia, Africa, Australasia, North America, Central America, and the West Indies and South America. In each case the length of line, gage and amount of rolling stock are briefly stated. The names of the chief officers are given, with the address of the managing director, chairman, or chief engineer, as a rule. In other cases the address of each official is noted. An index of officers, arranged alphabetically, is included.

POOR'S MANUAL OF THE RAILROADS OF THE UNITED STATES.—30th annual number, 1897, with an appendix containing a full analysis of the debts of the United States, the several states, municipalities, etc.; also statements of street railway and traction companies, industrial corporations, etc. H. V. & H. W. Poor, 44 Broad St., New York. Cloth: 9 × 5¾ ins.; 1,408 pp., with railway map of the United States. $7.50.

In our issue of Sept. 2 was published a general statement of railway statistics in the United States for 1896, abstracted from the advance sheets of this publication. To attempt any further and detailed review of the contents of this exhaustive report upon the railways of the country is impossible in the available space, and it would be comparatively valueless as compared with the work itself.

LIGHT RAILWAYS.—By F. R. Johnson, M. Inst. C. E. London: E. & F. N. Spon. New York: Spon & Chamberlain. Cloth; 7 × 5 ins.; pp. 31; illustrated. $1.

The opportunities which many parts of England and other thickly settled countries offer for the development of a paying system of lightly constructed, narrow gage railways connecting the farming districts ten or twenty miles remote with the main railway lines and the markets for farm produce, should make a comprehensive and well-written book on the possibilities, construction and cost of light railways of considerable value. The book before us, however, is superficial and incomplete, and considering the fact that the entire contents of this book could be printed on a single page of this journal, the price charged would be exorbitant even if the matter were of much higher value.

THE HIGHEST KITE-FLYING RECORD is said to have been made at Blue Hill Observatory, Mass., on Sept. 19. A string of seven kites, of the Hargrave type, attained an altitude of 10,016 ft. with about four miles of wire out. An instrument for recording pressures, temperature and humidity was swung 130 ft. below the topmost kite. At the highest point this instrument recorded a temperature of 38° while it was 63° at the surface. At 4,000 ft. the humidity rose rapidly, and sank again at about 5,000 ft.; at 7,000 ft. it reached a point of almost complete saturation and then became drier until at 10,000 ft. there was scarcely any moisture recorded. It took a small steam engine almost two hours to reel in the four miles of wire.

THE USE OF ACETYLENE FOR DRIVING ENGINES is, according to "Revue Industrielle," entirely possible, as shown by a series of experiments conducted at Compiegne by Cuinat. It was shown that acetylene develops fully three times the energy of the usual illuminating gas and that the only changes needed to transform an ordinary gas engine into an acetylene engine was a reduction in size of the intake valves. The best mixture was found to be 10 of air to 1 of gas. With these proportions it was found that engines ranging from 8 to 16 HP. cost about 6 cents per HP. hour, at the present rate of calcium carbide.

A TRACK-WALKER'S CHECK SYSTEM has been tried by the Pennsylvania R. R. Company on its New Jersey lines. Each track-walked is supplied with a bundle of checks, and his policing district touches that of another man at each end. When the patrols meet they exchange checks, after endorsing upon them time of meeting and other information, and each man then delivers his check at the signal tower at the opposite end of the beat. From this tower the information is at once wired to the Jersey City office. The purpose of the system is to keep in constant touch with the track-walkers, and every part of the line.

THE TOTAL MILES OF TELEGRAPH WIRE in the world has reached 4,908,921, not counting 180,440 miles of submarine cable. Were this all in one continuous line it would wrap around the equator about 198 times. The moon and earth could be connected by 20 lines, with enough to spare to connect every country on the earth. Of the total amount, Europe has 1,764,790; Asia, 310,685; Africa, 99,419; Australia, 217,479 and America, 2,516,548.

A NEW PHOTO-CHRONOGRAPH, for measuring the velocity of cannon balls, has just been completed by Mr. John A. Brashear, of Allegheny City. It is the second machine of this type made by Mr. Brashear and is an improvement on the first, as it measures time to the one hundred thousandth part of a second by photography. The movement of a single lever fires the gun, starts the vibration of a tuning fork, opens the main shutter and throws a beam of light on the photographic plate, which latter is revolving 1,500 times per minute. The ball, after leaving the gun, cuts a wire near the gun, another at a known distance from the first. Through a small opening in a diaphragm on one prong of the tuning-fork, a powerful beam of light is cast upon the plate, and the vibrations cause a sinuous track to be photographed alongside of a streak which represents the flight of the ball. After development the relations of the two photographic streaks are measured with a micrometer; and the method is so exact that a movement of 2 or 3 ins. can be noted. As no photographic shutter, that had weight, could be moved in the short time necessary, this machine has two Nicols prisms, lying at right angles to each other, upon which the light from an electric arc impinges. In the position of the prisms noted it was impossible for light to pass through; but Dr. Crehore discovered that if a powerful electric current be passed through a coil placed between the Nicols prisms, the light itself could be rotated without rotating the prisms. Electricity itself acts as a shutter in this case.

ANNUAL CONVENTION OF THE STREET RAILWAY ASSOCIATION OF NEW YORK.

The 15th annual meeting of the Street Railway Association of the State of New York was held at the International Hotel, Niagara Falls, N. Y., Sept. 14 to 16, and was the most largely attended meeting in the history of the association. After an address by the President, Mr. J. Tracy Rogers, of Binghamton, and the reports of the Executive Committee and Treasurer, the reading and discussion of papers began with a paper by Mr. W. W. Wheatley, of the Brooklyn Heights R. R., entitled "How Can We Increase the Efficiency of Our Employes?" The substance of the paper was that great care should be used in selection at the start, that discipline must be employed, which meant in its broadest sense that men should be educated and trained, and not merely punished for infractions of the rules. Companies should take an interest in the social surroundings of its employes, and give opportunity for enjoyment as well as improvement. Some incentive should be held to make men careful, and this should not be the fear of punishment. Every employe should be made to feel that a good record really meant something and would be appreciated. In the discussion following Mr. J. B. Cahoon emphasized the need of social provisions and educational efforts. He described some plans adopted in Elmira, such as reading rooms and the giving of a gold stripe on the sleeve with a slight increase of pay for each five years of service.

The next paper, "A Decade of Electric Railroad Development," was read by Mr. W. J. Clark, of the General Electric Co. This paper was somewhat general in its nature, but contained some tabulated statistics connected with operating expenses, receipts, etc., which will bear study. Considering the time from 1887 to 1897 it was pointed out that the motor cars in service in New York state alone had increased from nothing up to 6,000, and that street railway mileage had increased 156%. In the early days rails cost over double their present market price, electric car equipments from 250 to 400% more; power station equipments from 100 to 300% more. Mentioning wages, it was pointed out that in the Glasgow street railway system but 43% of the operating expenses went to wages while in Buffalo, N. Y., over 77% of the entire operating expenses is paid to labor; that out of $200,000,000 gross receipts $13,000,000 were paid directly to employes as wages. In connection with accidents it was pointed out that the proportion of persons killed to passengers carried has decreased each year.

Tuesday afternoon session was opened by a paper read by Mr. Caryl D. Haskins, Boston, Mass., and entitled the "Economical Influence of Accurate Electrical Measurement." The President next introduced Mr. T. J. Nicholl, Rochester, whose paper was entitled "The Advantage of a Car Mileage Record." This was an account of a system used in Rochester and emphasized the fact that mileage was the most satisfactory basis from which to figure expenses and receipts. The next paper, "Facts and Fancies of Railroads," by Mr. W. W. Cole, of Elmira, had as its object the necessity of educating the general public up to the fact that street railway companies did not spend their time and money bribing city officials.

"Track Bonding—How Can We Obtain the Best Results" was the title of a paper read by Mr. H. S. Newton, of Syracuse, which showed up in a general way the lack of care and judgment displayed in bonding the usual road, causing, in most cases, a loss of 10%. It laid stress upon the need of a true metallic return of ample size, and advocated soldering the bonds, the section of which should depend upon the location of the track, but should always be larger than now employed. In the discussion following it was stated that in the future suits for damage by electrolysis will be frequent unless greater care is used in bonding to prevent ground currents.

"Advantages of Up-to-Date Street Railway Service; Why the Rate of Fare Should Not be Reduced," was read by the Secretary in the absence of Mr. C. L. Rossiter, Brooklyn. The facts developed by this paper were rather general. In connection with rates and distances it was shown that to-day the distances carried for five cents ranged from 9.9 to 18 miles, while in the days of horse cars this limit was five miles and even less. Abroad the rates per mile are higher, being usually two cents for the first mile and one cent for each mile thereafter. In this country the average is from ¼ to ½ ct. per mile, and in many cases ½ ct. per mile.

Mr. J. P. E. Clark read a paper by Robert Dunning, of Buffalo, entitled "The Repair Shop," which briefly outlined the various shops, tools and arrangements most satisfactory in connection with a fairly good-sized street railway plant.

Wednesday morning, after a brief meeting, at which no business was transacted, the association adjourned to take an excursion to Lewiston.

At 3 p. m. the meeting reconvened, the President appointing Messrs. Moffett, Robinson and McCormack as the nominating committee. The first paper of the afternoon was by H. H. Vreeland, President of the Metropolitan Traction Co., on "Municipal Ownership and Operation of Street Railways." Mr. Vreeland started in by saying that this subject had been discussed too much from the standpoint of the municipality, and not enough from that of the railway company. His paper stated very strongly that municipal railway plants would not succeed, owing to the chances for political deals and the lack of personal interest.

Mr. H. S. Cooper then read a paper, "The Prevention of Accidents; the Best Method to Accomplish this End." This paper attempts to prove that the personnel of a railway has a large influence upon the frequency or absence of accidents; that the company using every effort to provide safety for passengers and men unconsciously forces its employes to be more careful. In connection with safety devices Mr. Cooper says:

"Therefore, the first and most important requisite is good men, men who are sober, industrious and reliable in word and deed. These you cannot buy in a scrap heap; they are standard goods and have a market value; so, if the price you pay your labor is below the market, don't hug yourselves with the idea that you have struck a bargain; ten to one that it is "scrap," and at the first "emergency stop," bang! will go a link or two."

In closing he said the question is, "How can we change this personal "danger element" into a personal "safety element?" With good men, suitable men, well paid, well cared for, well equipped, well watched, well disciplined, and permeated, saturated, soaked with what should be the instinct of every member of the company from president to the transgressor—the idea of safety in every duty they perform."

Owing to the lateness of the hour the following papers were read by title only:

"Low Joints—How to Prevent Them," C. Loomis Allen, Syracuse. An account of the methods employed in Syracuse. "Street-Car Wheels—Should They be Made Heavier." F. D. Russell, Rochester, briefly reviewed the increasing weight of car wheels, stating that a good standard would be a 33-in. wheel, weighing from 380 lbs. to 400 lbs. on 2¼-in. and 2½-in. tread. He recommended the adoption of a standard length of axle, bearing, etc. A paper, entitled "Construction and Maintenance of Car Bodies and Trucks," by Robert Dunning, Buffalo, completed the list. During the business session which followed, it was decided to have a committee to confer with the railroad commissioners of the state for the purpose of having a set of standard or uniform rules to govern the operation of street railways in New York state. The President appointed Messrs. H. H. Vreeland, New York; C. L. Rossiter, A. L. Johnson, Brooklyn; H. H. Littell, Buffalo; J. W. McNamara, Albany. The nominating committee submitted its report and the following officers were elected:

Pres., G. Tracy Rogers, Binghamton; First Vice-Pres., W. Caryl Ely, Niagara Falls; Second Vice-Pres., T. J. Nicholl, Rochester; Secy. and Treas., Henry A. Robinson, New York city. Executive Committee—Herbert H. Vreeland, New York city; John W. McNamara, Albany; Henry M. Watson, Buffalo; Clinton L. Rossiter, Brooklyn.

On invitation of Mr. C. L. Rossiter the association decided to hold the next convention in Brooklyn.

A vote of thanks was extended to the several companies and individuals who had made the meeting such a success, both from a social and business standpoint.

ANNUAL CONVENTION OF THE ROADMASTERS' ASSOCIATION OF AMERICA.

The fifteenth annual convention of this association was held at Old Point Comfort, Va., Sept. 14 to 16, with a fairly good attendance. A number of the western members met at Chicago and went east on a special car by the Cleveland, Cincinnati, Chicago & St. Louis and Chesapeake & Ohio railways.

The meeting on Sept. 14 was called to order about 9.30 a. m., and the President, Mr. R. Caffery (Lehigh Valley R. R.), delivered the opening address. He called attention to the value and importance of the meetings in regard to the improvement of track and track methods, and in keeping the members well informed as to new methods and new devices. Managing officers should insist on their roadmasters attending the conventions and should see that they have proper facilities for doing so.

The report of the Secretary showed receipts amounting to $2,235 and expenditures amounting to $1,506, leaving a balance of $729, which is larger than the balance for the previous year.

The election of officers was then taken up, and resulted as follows: President, A. M. Hawkins, Norfolk & Southern R. R.; First Vice-President, F. R. Coates, New York, New Haven & Hartford R. R.; Second Vice-President, J. M. Meade, Atchison, Topeka & Santa Fe Ry.; Secretary and Treasurer, J. B. Dickson (re-elected for third term), Chicago & Northwestern Ry.; Member of the Executive Committee for four years, J. Merrill (re-elected), Chicago, Milwaukee & St. Paul Ry.

A short paper on the preservation of cross ties was then read by Mr. J. M. Meade, Resident Engineer of the Atchison, Topeka & Santa Fe Ry., and we give this practically in full:

Treated Ties on the A., T. & S. F. Ry.

I have here a part of a treated tie which was taken out of the track of the A., T. & S. F. Ry. in New Mexico about three weeks ago. The tie was treated at Las Vegas, N. M., by the Wellhouse zinc-tannin process in 1885, and has been in the main line track for over 12 years. It is of mountain pine, and is still in good condition. We generally let the ties season for about six months, and they are then treated in long iron cylinders. It usually takes from 2 to 3 hours to steam the sap out of a tie, and then the products of condensation are drawn off and the air is exhausted from the cylinder by means of a vacuum pump. The chloride of zinc is then admitted, and a pressure of 100 lbs. per sq. in. applied for about 3 hours. The absorption of the chloride is about 2%, and the rest of the solution is pumped back to the vats. A glue and tannin solution is then applied to seal the ends of the ties and keep the zinc solution in the grain of the wood. We find that the zinc solution enters the wood lengthwise with the grain, and not from the sides. The glue and tannin are very beneficial in preventing rain and dampness from leaching out the chloride of zinc. We consider the Wellhouse process much better than the plain zinc-chloride or Burnetising process.

The volcanic sands on the southern portion of our road rot out ties very quickly, and we find that the native mountain pine ties last only from 3 to 4 years when not treated. We are now convinced, after 12 years' test, that the application of the chemicals will treble the life of the tie, besides adding about 20% to the holding power of the spike. The present cost of treating is about 13 cts. per tie, varying a little according to the cost of the chemicals. This includes the cost of labor in handling the ties in and out of the works and sawing them to a uniform length. I think this is one of the subjects which we should take up for discussion at our next annual metting.

A paper by Mr. H. W. Church (Lake Shore & Michigan Southern Ry.) on "Methods of and Reports for Directing and Supervising the Work of Section Foremen" was then read by the Secretary, and of this paper we shall publish an abstract. There was then a brief discussion in a proposition to change the time of the next meeting from September to October, after which a vote of thanks was passed to Admiral Sicard, of the North Atlantic Squadron, for offering the Association an opportunity to visit the several warships in the harbor. The meeting then adjourned.

In the afternoon several parties went out in naphtha launches to visit the ships of the squadron.

In the evening, at 8.30, Mr. E. E. Russell Tratman, Assoc. M. Am. Soc. C. E., Associate Editor of Engineering News, delivered an address on "The Duties and Responsibilities of the Roadmaster," pointing out the importance of the roadmaster and his track in relation to the economical operation of the road, and dealing also with some of the much needed improvements in the roadway department. The President, Mr. Caffery, in suggesting a rising vote of thanks, said that the paper showed very clearly the difficulties which every roadmaster has to contend with, and it was voted that the address should be published in the proceedings of the Association and that copies should be sent to managers and operating officials in order to call their attention more particularly to the importance of the roadway department.

On Sept. 15, the first subject for presentation should have been the report of the committee on "The Best Method of Preventing the Creeping of Rails," but no report had been sent in by the committee, and after some discussion over the inconvenience of such a failure it was decided to appoint a new committee, to report at the next convention. The report of the committee on "Tie-Plates" was then presented, and was mainly as follows:

Tie-Plates, the Benefits and Results Obtained from Their Use.

The result of our observation and experience with the tie-plate is, that when properly designed it is superior to the rail brace, in not only performing the function of the brace, but also in possessing additional merit of its own.

The function of the rail brace is to prevent the widening of the gage by transmitting through the brace to the tie a part of the lateral thrust which otherwise would pass to the outer edge of the base of the rail, and also to prevent the outward turning of the rail in consequence of its cutting into the tie. The rail brace only partially accomplishes this, for no matter how well a curve may be braced the strain of tangential force on the outer rail by fast moving trains and the abnormal weight upon the inner rail by slow and heavy trains, combined with the grinding or abrasion of the tie by rail flexture, cause the outer edge of the rails to gradually cut into the tie and change the position of the rails, and as a result the gage is increased and the head of the rails are badly worn. When this is the condition it is impossible to economically maintain good and safe track. To restore the rails to their normal position, the tie must be adzed and the spikes pulled and re-driven, all of which tend to reduce the life of the tie.

The rail brace does not prevent the rail from cutting into the tie, and when this is the condition of the ties much of the wheel pressure is transmitted through the head of the rail to the brace, making it a lever with the fulcrum near the base of the rail, and when in this position the spikes which secure it to the tie offer but little resistance to the track spreading or rail turning; a fact well known to every roadmaster. By using a properly designed tie-plate the cutting of the tie may be prevented and the gage maintained without the aid of the rail brace.

The extent to which the life of the tie may be prolonged by the use of the tie-plate depends upon the traffic, the kind of tie timber and a full knowledge of the existing or governing conditions. For example on switch leads, where the track is in constant use, it would undoubtedly outlast several tie renewals; and on bridges, where the ties are more expensive, and where the labor of renewing them is considerable, they are a wise economy. Also on main track under traffic where the ties are worn by abrasion due to the wave motion of the rail, the tie-plate would undoubtedly prolong the life of hardwood ties from one to three years, and soft wood from three to six years.

As smooth riding curves are desirable in practical track work as well as essential in general railway operations, your committee believes in the use of the tie-plate on hardwood ties on curves of 2° or more; on all joint ties on tangents and curves of less than 2°; and on all joint ties on tangents and light curves. A plate being under each rail on each tie, would result not only in a saving of labor and material, but in obtaining a higher standard of excellence, as next to rail, ties and ballast, the tie-plate is indispensable in securing good gage, line and surface.

In addition to the saving (1) in rail, by reducing to a minimum the wear due to impacts and the uneven wear due to the rail getting out of position; and (2) in spikes, by fewer being cut by the vertical and lateral movement of the rail; and (3) in ties, by preventing the rail from cutting into them, and by less spiking to rectify the gage, thus prolonging their life and reducing the yearly renewals, which itself would warrant the favorable consideration of the plate, the advantages to be obtained by the use of the plate are better surface and gage; the maintaining the rail in its normal position enabling the motive power to be used more efficiently; the decreased wear and tear of rolling stock, and the generally economical operation, not only in the movement of freight but also in safety to passengers.

In the passing of heavy fast trains there is a vibration transmitted through the track from the rail to the tie, thence to the ballast and thence to the road bed. This vibration is more easily and economically conveyed to the latter when there is a perfect union of the parts, that being a condition essential to the economical maintenance of all track. Therefore, it is the opinion of your committee, that an essential feature of the tie-plate is that it should have perfect mechanical union with the tie to prevent vertical and lateral movement, which would result in the working loose of the plate and widening of the gage or spreading of the track. It should be so designed as to contain the necessary amount of material, properly distributed or proportioned, to successfully withstand the use to which it may be subjected, and should protect the tie from cutting and consequent decay, and its adhesion be such as to hold the track to gage and prolong the usefulness of the spike. In order to obtain the best results from the tie-plate, it should be properly applied, the tie being well adzed to an even bearing for the plate, so as to decrease the tendency for it to buckle. It should be imbedded in the tie when applied and not left for the train to settle to position, thus exposing it to the liability of sand and gravel to get under to bend it. It should be so punched as to secure a snug fit to avoid any lateral movement of the rail, and the spikes should be driven vertically. E. E. Stone, J. A. Dodson, J. C. Hechler, D. H. Lovell, Geo. M. Brown, Reuben P. Collins.

The discussion brought up several of the old and oft-debated points. Mr. Jones (Chicago, Burlington & Quincy R. R.), made a motion that the report should recommend that all tie-plates taking the place of rail braces should have an outer rib or shoulder extending the full width of the plate, in accordance with the recommendations of the report of last year. He thought that if this was not done it would seem as if the association had receded from the position it took last year. Mr. Black (Manhattan Elevated R. R.) and Mr. Coates (N. Y., N. H. & H. R. R.) could see no advantage in the shoulder, but Mr. Hill (Southern Pacific Ry.) pointed out that this shoulder was only recommended for curves, its purpose being to take the lateral thrust of the rail rather than to prevent wear of the neck of the spike. A vote resulted in laying the motion on the table. In regard to setting tie-plates Mr. Hill stated that he uses a 16-lb. sledge, with a piece of steel rail as a follower, while for bridge ties the plates are set by a template and driven home by a pile driver with a fall of 2 or 3 ft. Mr. Black uses a 12-lb. sledge, but does not try to drive the plates in flush with the tie; it was pointed out, however, that on this road there is no trouble from ballast working under the plates, as on ordinary track. Mr. Meade moved that the new committee on the subject include an engineer, and that actual results obtained with various forms of plates be investigated, in the same way as has been done by a committee of the American Society of Railroad Superintendents. This was carried, as was also the following resolution submitted by Mr. Coates:

It is the sense of this Association that the tie-plate is of great value in point of safety and economy. While not recommending any special make of plate, we would respectfully suggest that some pattern be used, as the experience of roadmasters has fully demonstrated the economy and safety resulting from the use of tie-plates.

The next matter was the presentation of the report of the committee on "Rail Joints," and this brought out the usual amount of discussion. Mr. Meade said that after experimenting with the Heath joint the A., T. & S. Fe Ry. has gone back to the long angle bar on three ties, the Heath joint being difficult to hold in line. Mr. Dickson (Chicago & Northwestern Ry.) said his road had long angle bars which are too long for short bars and too short for long bars. These gave trouble through not being slotted over the middle tie, so that they creep ahead. Channel-shaped base plates or bridge plates have been in use since 1889. Mr. Black referred to the satisfactory experience of the Manhattan Elevated R. R. with the Weber bridge joint, and Mr. Coates spoke as to the general advantages of the bridge type of joint. A motion by Mr. Jones was carried, to the effect that the last paragraph of the report be put in the shape of a motion and submitted to the American Society of Civil Engineers. The report is substantially as follows:

Your committee concluded that it would not try to show the good or bad qualities of any of the joint appliances of recent invention, but make the issue alone on the practically universal joint now in use—the angle bar—and, by showing the inefficiency of the angle bar as compared to the rail, to show why there should be a better appliance furnished, if we are to keep the track smooth.

There is no one thing that affects the track so much as the joints, and this is not only in the safe and smooth riding of the cars, but the expense of maintaining a good track would be very much less if the joint appliance would give the same strength as any other part of the rail; and we believe it would be economy to have a better joint appliance.

Perhaps the most painstaking and exhaustive treatment of the subject is that of the Association of Engineers of Maintenance of Way, of the Pennsylvania Lines, West of Pittsburg, Mr. J. C. Bland, chairman.

The experiments were upon and the deductions made from the Pennsylvania Railroad pattern 85-lb. rail, and from it we gather that the capacity of a pair of angle bars in conjunction with the rail which they unite, is much below that of the rail, and that the capacity of the angle bar as a supported joint (either one or three ties) is below that of a suspended joint. So, leaving out entirely the supported joints, we reach the following conclusions, most favorable to the angle bar:

(1) In normal bending action, that is under quiescent loading, the bars are deficient in compressive resistance; and, therefore, the compressive resistance, which is only 68.6% of the ultimate resistance, will govern the life of the bars.

(2) That the proportion of the loading on the angle bars and the rail which they unite will be as their respective stiffnesses, and that with the loading over the joint, the angle bars have to carry from 53 to 56% of the full load on the joint.

The static capacity of the Pennsylvania R. R. 85-lb. bars in conjunction with the rail is 72,400 lbs. repeated indefinitely. The capacity to resist frequently applied, oft-repeated loads, is 36,200 lbs. The capacity to resist suddenly applied, oft-repeated loads, with reversal of stress is 18,000 lbs. Thus, the 85-lb. angle bars, in conjunction with the rail, has a capacity to resist suddenly applied loads ranging from 36,200 to 18,100 lbs. Between these limits lies its strength.

The capacity of a pair of 85-lb. angle bars in conjunction with the rail being 36,200 lbs., and under the same conditions of loading, that of the unbroken 85-lb. rail being 68,700 lbs., the efficiency of the No. 85 angle bar joint is 52.4%. Or, in other words, though the bar has more than half the work to do, it is, from its construction, only a little more than one-half as well able to do it.

Therefore, though at the joint the bars have to carry from 53 to 56% of the full load at that point, they are in conjunction with the rail only 52.4% as efficient as the unbroken rail.

As to the cost of the maintenance of the angle bar joint, it is exceedingly difficult, from the nature of the work, and from our method of time keeping, to arrive at an exact figure as to the amount directly chargeable to this, but from the best data obtainable, the amount lies between 20 and 30% of the total labor account of all section forces.

In conclusion, your committee concur in the opinion of Mr. Bland, that the joint should be one "whose life will be equal to, or greater than, that of the rails which it unites, and whose form is such as will enable us to maintain a good riding surface at a minimum cost." In short, we want a joint simple and mechanical, which will be of a material tough and ductile, and of a higher elastic capacity and ultimate strength than the rails, in order to compensate for the already shown deficiency in strength ratio.

From the foregoing it is manifest that it is not to be expected that we can keep up the joint with the present angle bar, and we, as a Committee on Rail Joints, ask any and all those having joint appliances to show by actual tests and mathematical demonstration that they have a better joint than the angle bar.

Recognizing the broadness of the field, and the good results that have been secured through discussion by this body, your committee suggests that the American Society of Civil Engineers, to whom we are indebted for standard sections of steel rails, be respectfully requested to take up and consider what form of rail fastening is necessary at this time to provide for the increased weight of cars and engines, and the fast speeds now necessary to secure profitable financial results for the railway company, and let us have the benefit of their experiments, we giving them the assurance that if they will undertake it, every assistance in our power will be rendered.

At a short afternoon session the report of the committee on "Tie Renewals" was read, and was adopted after very little discussion. The report was substantially as follows:

Is it More Economical to Put in Ties Out of a Face or in Patches?

Putting in ties "out of a face" means to replace every tie in a given distance. "In patches" implies putting in new ties here and there where they may be needed.

1. All timber ties are of two general classes, hewn and sawed; these in turn may be subdivided as follows: Hewn (a) quarter tie; (b) slab tie; (c) half tie; (d) uneven tie; (e) pole tie. Sawed (a) quarter tie; (b) slab tie; (c) half tie; (d) pole tie.

2. The wood entering into ties is of great variety, ranging from cedar and other soft woods to lignum vitae.

3. The density or hardness of wood of the same species varies greatly.

4. The dimensions of ties vary; this is especially so in regard to width of face.

5. There is great difference in the life of ties.

6. The amount of labor expended in handling and renewing ties.

When ties are put in patches, the track is torn up at different places, which necessitates temporarily hard and soft spots. The tie supports are not equal, being of different size and age. Only those ties which are worn out will be removed, and the old ties remaining keep the track to line.

By renewing ties out of a face, every one, be it good or bad, partly worn or otherwise, must be removed. The track will be rough only on the stretch which is being renewed, as the bed will be disturbed, thus impairing the surface and line, and it will require the expenditure of considerable labor to put this track in its former riding condition.

To attain the theoretical results from this method of renewal, it would be necessary for the first five conditions, previously mentioned, to agree in the ties. In other words each tie is an exact counterpart of the one next to it. They should all be of the one style, of the same kind of timber, the density of all being alike, dimensions all the same, and of equal life.

From a practical standpoint the question arises as to the method of disposing of the partly worn ties. As all new ties are used in the renewals of the main line tracks, the partly worn ties must necessarily go into the side tracks. In view of this fact we have a tie which in some instances will last two years if not disturbed; it is taken out of the main line and placed in the side track, where, owing to its having been rehandled, its life is somewhat impaired, and though there is less running over it, it will not last much longer than it would have in the former place.

Assume a first-class tie to cost 40 cts. and a second 20 cts. The labor necessary to renew a tie in stone ballast will amount to about 15 cts., and in gravel to about 10 cts.; this includes removing the old tie, putting in the new one, and tamping once. The life of a tie is taken at seven years. As previously stated, in renewing out of a face we will consider a tie (and there are many of them), which if not disturbed would have lasted two more years. The cost of this tie per year is 5⅞ cts. To remove it will cost one-fourth of 10 cts. (for gravel) or 2½ cts. The cost of labor necessary to replace it in the side track is 10 cts. Then, not considering the cost of handling, we have:

Cost of tie at 5⅞ cts. per year for two years	11½ cts.
Cost of removal	2½ "
Cost of renewal	10 "
Total	24 "
A new second-class tie which would last seven years, would cost	20 "
Cost of renewal	10 "
Total	30 "

In the former case the cost per year for side track is about 12 cts., in the latter 4 2-7 cts. Hence, from this standpoint no saving is effected.

A financial loss is also occasioned by removing a tie from the main line before its efficiency is exhausted. Assuming that a first-class tie costs 40 cts., at 5% the loss is 2 cts. per year, or in two years 4 cts. These seemingly small losses involve dollars when a few thousand ties are removed before the expiration of their natural life; and in addition to this loss there is the undue labor which has to be expended to keep the new tie properly lined and surfaced.

The object of all trackmen is to have the tie-supports so placed as to give the best distribution to the passing wheel loads. Considering the statements made in regard to timber ties, and under the present conditions, the theoretical is never attained. To reach this point would mean the rejection of a vast number of ties that are now accepted, and as this condition is one of the strongest points in favor of renewing ties out of a face, and as previously shown it is never attained, the committee is of the opinion, in view of this fact, also for the safe keeping of the tracks and in the interest of economy, that ties should be renewed in patches.

Of course there are exceptions to every rule. Where renewing is done under adverse circumstances, such as in tunnels, under road crossings, station platforms, etc., they should be put in out of a face.

In the discussion Mr. Hawkins (Norfolk & Southern R. R.) pointed out that the question of renewal depended largely on financial conditions, as in some cases a man will be glad if he can obtain two new ties to a rail, it being then impossible to think of renewing all ties. Mr. Caffery (Lehigh Valley R. R.) considered, however, that the discussion should be as to the best and most economical plan of doing the work in itself, without considering financial limitations. The association then adjourned to allow the members to take a steamer for a trip about the bay and harbor.

On Sept. 16 the first business taken up was the report of the committee on "The Latest Improvements in Frogs and Switches," an abstract of which is given herewith:

Latest Improvements in Switches and Frogs.

Within a short period of fifteen years, spring frogs of various designs have almost entirely taken the place of rigid frogs for main line purposes. Of the various designs there is but little difference in the main points of construction. The placing of ⅛-in. steel plates on every tie, under the full length of the frog, to prevent the wing rails from cutting in, anti-creeping devices, sufficient holding down pockets for wing rails, steel raising blocks, steel or malleable iron spring covers, reinforcing bars or rails on the movable wing rails, channeling wing rails to accommodate worn tires, are some of the essential points and recent improvements in an ordinary spring frog.

All steel used in the construction of frogs and switches should be of the best quality, with an ultimate tensile strength of not less than 50,000 lbs. per sq. in. The rails should be bent cold, the bends being circular and not angular. The planing should be true and all abutting surfaces shoud fit closely. They should have coped joints and the cutting in of the main point rails should be ½-in. The base of the long point should be cut out, but the short point should be fitted over the long point by careful and proper planing. Point rails should be securely riveted with not less than ⅞-in. rivets. The bend in the wing rails at the point should be in the arc of a circle. Drilling for all bolts in spring rail frogs should be on a line perpendicular to the main track rail. The fixed wing rail and point should be bolted together with a sufficient number of 1-in. bolts to make the frog rigid and durable. The movable wing rail should be bent so as to fit closely against the point rail from the beginning of the flare to within 8 ins. of the working point. Reinforcing bars of suitable dimension, with proper holding down plungers perpendicular to the bar, and a suitable number of stops riveted onto the base plates to allow an opening of 2 ins. between the wing rail and working point. Springs of various designs are used and the location is a matter of choice. Fillers, solid and continuous, should be used and planed to closely fit the rail section. The drilling for all bolts shoud not be more than 1-32-in. larger than the bolt to be used. Steel raising blocks should be placed at the heel of the frog with a firm bearing upon the bottom flange of the point rail and securely bolted. The line and surface should be true, and no paint or other covering should be used until after the frogs have been inspected and received.

The sliding spring frog, which is a recent design, and may be used either for main line or yard tracks, may be classed as a late improvement. The greatest advantage over an ordinary spring frog is the changing position of the wing rails according to the direction of the train, thus reducing the pounding features of the half-spring or rigid frog. It renders a full bearing at the working point in either direction of the train, thus reducing the wear to the wing rail, as is commonly the case in other designs.

Another line of improvement in the frog device is the continuous rail connection, which is gradually gaining indorsements and doubtlessly the prejudice held out against it by many will eventually be overcome. By ... absolute continuity for main track is attached, especially at points where high speed is reached. In a continuous rail connection the switch, frog and signals are operated in unison by a system of pipe line and bell crank adjustments. The switch being set for the turnout, the wing rails of the frog will closely abut against the stock rail and by proper elevation blocks will be raised above the stock rail. The wheels of a car entering the siding passing above the stock rail as in a Wharton switch. To render it safe and ensue quick handling, this frog and switch should be operated by an improved method of interlocking, and properly protected by signals.

There has been but little advancement in the way of improvements to rigid frogs of recent date. A rigid frog should be so constructed as to render it rigid in the fullest sense of the term. With inferior fastenings the frog soon becomes loose, which results in the battering down of the wing rail at the working point, and if not given constant care and attention when traffic is heavy, it soon goes to pieces, finds its way to the scrap pile and another frog is called for.

Bolted frogs should have coped joints, the same as described in the spring frog. The drilling for all bolts should be perpendicular to the axis of the frog and supproved spring nut lock should be used, and should be ⅝ to 1-in. thick to properly protect the frog. The flared end of the wing rails should be bent on an angle of 1 in 8 with the flared end not less than 4 ins. from the gage line. Bolts from 1 to 1⅛-ins. diameter with some approved spring nut lock should be used, and should be supplied with beveled iron washers so that the bolt heads and nuts will have a firm bearing.

In clamped frogs the vertical clamp gives the best results in many ways. Clamps forged to closely fit the rail section and held in place by adjustment rods, with solid and continuous fillers, are some of the recent improvements. This improved method of clamping is superior in some ways to an ordinary bolted frog, or to a frog clamped by other methods. It requires little attention to keep them in repair, thus assuring a longer continuance in service. The objectionable features, however, is the clamps coming in contact with the switch timbers in complicated yards, and this criticism can justly be applied to all class of frogs in which the clamps or fastenings come below the frog base.

The Tyler & Ellis hydraulic pressed frog is something new in the States. It was designed some years ago by Mr. Price Williams, a well known English engineer. At first the method of manufacture was too crude to be practicable, but recently patented machinery has made it possible to manufacture them satisfactorily from a commercial standpoint. It has been successfully used in England for two years. The advantages in this frog over other forms are as follows: Absolute continuity of track. There is no break in the main track as the rail is heated and grooved or the flangeway pressed into the head by hydraulic machinery. The metal so displaced goes into the web to strengthen it, no metal being cut away. The base is left intact and renders stronger construction than an ordinary rail frog. This construction also allows better alinement and surface, and the jump so injurious to railway equipments is avoided. It is claimed this style will outlast two of the existing styles of frogs.

Mr. J. G. Rodgers, Supervisor of Subdivision No. 1, Pennsylvania R. R., West Philadelphia, Pa., says: "We have had this frog in very severe service since Sept. 7, 1896, and it has given very satisfactory results. It is so constructed as to have the lasting qualities of a spring rail frog without the disadvantages of possible accident from broken springs, etc. It wears on one side as rapidly as the ordinary stiff rail frog but costs only about half as much. At the point where we have it in service a stiff frog lasts about three months. This one has been in use almost four months and bids fair to last a couple of months longer."

The construction of the modern type of split switch is now almost the same by the various makers. The new features are, however, to be constantly found in the tie-bars and the connections with the switch stand. The early practice inclined to a pair of point rails 15 ft. long, tied together by four or five rods. These rods are applied in many ways; some being placed vertical and others flatwise, attached by specially formed lugs or socket castings.

The most recent practice is doing away with a multiple of tie rods, and reinforcing the switch rails. This decreases the liability of fracture of the rail, which if broken is held together by the wrought iron reinforcements. Where but one rod is used (commonly called "head rod") the device for taking up the lost motion due to wear, has earned the name of "adjustable head rod." A turnbuckle is used by some manufacturers, while others use a "key wedge adjustment." There is a difference of opinion as to the respective merits of the various devices for adjusting the split switch so that it will fit snug against the stock rail. A snug fit is desirable, and is not disputed, but it is held by some that a turnbuckle is very likely to be tampered with by persons maliciously inclined, which may give room for criticism, but possibly this could be overcome by an improved or secret nut lock.

Split switches recently adopted by some of the trunk lines and exclusively used, are, in a sense, constructed quite the reverse from single rod switches, with reference to the switch rods; the tendency being rather to increase the number of rods, as noted by the following specifications:

60 and 70-lb. rail, 18 ft. points have five rods; 80 and 85-lb. rail, 21-ft. points have six rods; 100-lb. rail, 24-ft. points, and seven switch rods, ¾-in. thick and 2 ins. wide.

Of the reinforcing bars, as recently applied to the split switch, of which there are several designs, those bolted on the outside of the switch rail are said to give the best results. They are made to closely fit the rail section and extend from the switch point to within 3 ft. of the heel. The bolts in the reinforcements have socket heads to prevent interfering with properly closing the point against the stock rail. The bars are supplied with stop blocks or lugs at a distance of 11 ft. from the switch point. The head or point rod bolts are machine-turned. In 18 and 21 ft. switches there are nine pairs and in 24-ft. switches twelve pairs of base plates provided with necessary raising plates of approved design, ½-in. thick and usually 4½ ins. wide. The risers in the base plates are formed by striking up the main plate, and placed so as to abut against the inside flange of the stock rail. The height of raiser plates conforms to elevation of the bottom of the switch rail, and all plates are marked showing the weight of the rail for which they are intended, by numbering or stamping to show the proper location.

In the discussion Mr. Price stated that he had a sliding frog in the main track which gives satisfactory results. Mr. Coates (N. Y., N. H. & H. R. R.) had tried each kind of rigid frog under similar conditions and found a bolted frog on tie-plates better than a plate on yoke frog. Mr. Bryan preferred a bolted and filled frog riveted to a plate. A vote on the three main types of rigid frogs, independent of such combinations noted above, resulted as follows: Bolted and filled frog, 29; riveted plate frog, 9; clamp or yoke frog, 7. The discussion then turned on the question of switch rods. Mr. Black (Manhattan Elevated R. R.) uses a single head-rod, with switch plate the entire length of tie and with reinforced switch rails. Mr. Ware thought the single rod specially advantageous in winter. Mr. Doherty considered that one rod was a source of danger, and made it difficult to maintain the gage. Mr. Redding said he could not use a plate along the tie as it would interfere with the track circuit of the block signals, but any foreman ought to be able to maintain the gage of his switches. Mr. Coates stated that his road uses five tie-rods and a plate along the tie, but prevent the latter from interfering with the track circuit by cutting out the entire switch by insulated joints. On a 15-ft. switch on the outside of a curve in a yard he has a long and a short switch rail, with a guard rail coming close to the point of the short rail. The discussion was then closed, to be continued at the next convention.

The President then announced the appointment of a committee to consider amendments to the constitution and to report at the next meeting. Mr. Ellis, of the committee on resolutionse, then presented a series of resolutions expressing regret at the loss of certain members by death, and expressing the thanks of the association to the manager of the hotel, to the supply men, to the committee of arrangements, and others, for courtesies shown and entertainments provided. The next matter was the consideration of the place for holding the next convention, and Denver was selected by a large majority. The time will be the second Tuesday in September, 1898. After the installation of the new officers, and brief addresses by these officers, the convention adjourned.

In the afternoon there was a trip by steamer to Norfolk and thence by rail to Virginia Beach, on the Atlantic coast, and after a stay of about one hour the party returned to Norfolk, where the members separated, departing by various routes.

Exhibits.

There was a good show of exhibits of track supplies and material, a general list of which will be found on another page, but we may mention here some of the novelties of general interest: In track tools there was the Sterlingworth spiking bar, shaped like a pitchfork, intended for holding up ties while spikes are being driven (the fork straddling the rail); also the Welsh spring-jaw clawbar, and the Buck track gage, giving the elevation and degree of curve and widening of gage. In the tie-plates there was the Goldie narrow plate, only as wide as the tie (except for the outside shoulder), intended to prevent buckling, and the Goldie tie-protector, which is simply a short tie-plate about 1 in. wide, for use on light track with light traffic, where the expense for ordinary tie-plates is an objection; also the Harris tie-plate, with split sleeves fitting into bored holes, the sleeves being spread by short stub spikes. In cattleguards there was Buck's "chain" cattleguard, like a row of link chain belts parallel with the rails, and the Climax cattleguard, built up of ribbed blocks of vitrified shale.